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Co-operation among Societies At the annual convention of the American Institute of Electrical Engineers on June 24 a suggestion was made by Dr. William McClellan that there be formed an "American Engineering Association," the object of which would be to bring together for unified action on important national and economic problems of an engineering nature the national engineering societies of the country. There would be no membership by individuals, but the societies would elect representatives who would form the association suggested. In addition to taking up such matters of general engineering interest as the registration of engineers, the status of the engineering profession and other large problems affecting all engineers, the association would arrange an annual convention for the discussion of general engineering problems. The suggestion is certainly one worthy of careful consideration. The necessity for unified action has been sorely felt in the past and the existence at the present time of a joint committee composed of representatives of these societies, to draft a registration bill, is an evidence that there is need for closer relations than now exist. The suggestion has the advantage of leaving the present national societies undisturbed and does nothing more than substitute for sporadic committees a permanent standing body ever alert to take up matters affecting the engineering profession as a whole. In fact, the body might better be called the "Standing Joint Committee of the National Engineering Societies." The proposition was favorably received by the electrical engineers and it is hoped that civil engineers will join in the discussion so that all the advantages and disadvantages may be brought out.

Erdman Act Amending the The long-drawn-out controversy between the railroads and the firemen preceding the recent arbitration gave undoubted evidence that if the Erdman act is to be applied to any large extent in important disputes the number of arbitrators will have to be increased. It was pointed out at the time that with only three members on the board the ultimate decision in a controversy involving millions of dollars is in the hands of one man, the third party selected by the two partisan arbitrators or appointed by the presiding judge of the Commerce Court and the commissioner of labor. An amendment recently proposed would increase the number of arbitrators from three to six, two each to be appointed by the parties in the dispute and the remaining two to be chosen by these four or, in case of their failure to agree, by a board of mediation and conciliation. This board, which is to be created by the proposed law, is to be composed of a commissioner and an assistant commissioner and not more than two other officials to be appointed by the President. While even a board of six does not come up to the standard set by the Straus board, which arbitrated the differences between the railroads and the locomotive engineers, in which the public had a representation exceeding that either of the railroads or of the employees, it is a distinct advance on the board of three. The proposed amendment has the endorsement of quite a number of railroad presidents, of the presidents of five brotherhoods and of Judge Martin A. Knapp and ex-Commissioner of Labor Charles P. Neill. The Senate has already passed the amendments and there is reason to believe that the House will also act favorably.

Economy in Drafting The advantages of small-sized drawings have been repeatedly emphasized in these columns, but the economies are so marked that it is worth while directing special attention to the short article on page 54, explaining how 8 x 10 sheets are used for practically all work by the Western Canada Power Company. Naturally in working out any such system many small difficulties will arise that can only be properly solved after a considerable amount of experience, and that such has been the case with the Western Canada company is evident from a reading of the article referred to. Two additional kinks have been adopted which are well worth incorporating or at least studying—the lettering of drawings with the typewriter and the use of colors instead of conventions for indicating steel and concrete areas. These are characteristic of the sort of improvements, each small in itself, which added together make a total saving that is by no means an inconsiderable percentage of the entire drafting-room cost.

Water Supply of High Buildings Skyscrapers offer a great variety of difficult engineering problems, aside from those of framework and foundation, which appeal particularly to the civil engineer and the contractor. Without striking advances, however, in other lines, making satisfactory water, heating, lighting, elevator and telephone service possible, structures like the Woolworth Building would still be in the realm of fancy. As an indication of the problems encountered in water supply alone there is printed on page 44 a description of the installation in the Woolworth Building, a fifty-five-story structure recently completed in New York. The problem here was not only to fill the sanitary wants of 8000 tenants, through the medium of more than 2000 fixtures, some over 700 ft. above street level, but to supply the large quantities of water needed for fire protection and the mechanical equipment used in the operation of such a structure. Some idea of the requirements can be gained from the fact that the pumps have a capacity of 2,000,000 gallons per day, and that the avoidance of excessive pressure at the fixtures demanded the division of the structure into five horizontal zones of about ten stories each. The complications involved in the fire-protection requirements and in duplication of lines to prevent interruption of service are too many to be gone into here, but a reading of the article will show clearly that the correlation of the various systems and the safeguards required make up a problem exceeding in difficulty the water supply of many a small city.

Waterproofing Concrete The report of the committee on waterproofing materials of the American Society for Testing Materials printed on page 39 carries, in a fashion, corroboration of two quite different points of view. It has been contended by many engineers competent to speak that with properly graded aggregates waterproofing materials, either incorporated in the mass or applied to the surface, were unnecessary. On the other hand, there were others who contended that both the nature of field work and the conditions as to temperature and moisture to which concrete is often subjected make provisions, additional to satisfactory proportioning, necessary. Within certain definite limits, pointed out in the committee's report, both sides are in the right. While there is ample evidence that with properly graded aggregates 1:2:4 and 1:3:6 concretes are impermeable when mixed and placed under laboratory conditions, the difficulty of securing equally satisfactory workmanship in the field frequently warrants the addition of some waterproofing material to the concrete. Moreover, it has been found that in large constructions, no matter how carefully the concrete itself has been made, cracks are apt to develop due to shrinkage in drying out, expansion and contraction under change of temperature and moisture, and by settlement. The committee, therefore, recommends that in especially difficult or important work a combination of void-filling and extraneous waterproofing be adopted. The conclusions reached by the committee are another illustration that sweeping generalizations as to engineering matters are apt to fall short of the mark and that the only conclusions that are safe are those tempered by an appreciation of the variations in conditions.

Electrolytic Corrosion The Bureau of Standards at Washington has been engaged for some time past in an investigation of electrolysis and its mitigation. As a forerunner of its final report covering the entire field of study Messrs. Burton McCollum and K. H. Logan presented before the annual convention of the American Institute of Electrical Engineers last month a paper dealing with certain fundamental laws governing electrolytic corrosion of iron in soils under conditions approximating as closely as possible those encountered in practice, both as regards soil conditions and current densities. Their conclusions are summarized on page 34. Among the factors which were found to exert the most marked influence upon electrolytic corrosion were current density, moisture, oxygen, temperature and voltage. The results are expressed in terms of the "efficiency of corrosion" or the percentage which the actual corrosion is of the theoretical corrosion as determined by Faraday's law. In general the lower corrosion efficiencies were obtained at the higher current densities. As regards moisture, the amount of corrosion per ampere-hour is likely to be quite low in the case of fairly dry soils while as the percentage of moisture approaches that corresponding to saturation the corrosion efficiency approaches 100 per cent. This factor, of course, is important in the location of pipe lines and should be considered in relation to the depth at which the pipe is laid, inasmuch as the moisture content of the soil varies with the depth. Other conditions being equal, however, depth of burial of pipes has no direct effect, nor do the different kinds of iron, employed in commercial service for underground pipes, so the investigators report, show results which differ appreciably. It appears, however, that the differences noted in practice, particularly in favor of cast-iron, are due to various other causes, pointed out by Professor Ganz and others; these are higher resistance in joints, higher specific resistance of the iron, heavier walls and a tendency to corrode more uniformly.

Motor Trucks for Contractors

The comparative slowness with which contractors are adopting the motor truck was discussed at a recent meeting of the Motor Truck Club of New York City. While, perhaps, few new arguments were presented there is food for reflection in the ideas of both the advocates of motor trucks and the doubters as to their value to the contractor, exaggerated though some of them may be.

It seemed to be generally conceded that the truck must be better adapted to the particular use to which it is put—that the manufacturers must stop selling "standard" types that do not fit the special requirements of the contractor. Despite this feeling, however, the motor truck has made a fair advance among contractors and has proved satisfactory where its adaptability and economy were given careful consideration before deciding to replace horses and settling upon the particular type of equipment to be used.

As an argument for the use of horses Mr. C. A. Crane, secretary of the General Contractors' Association, pointed out the ease with which the equipment can be temporarily augmented by renting more horses. This, as he says, is not the case with motor trucks, which cannot be rented as desired. While renting companies for auto trucks are a probability of the future, the comparative smallness of the horse unit is undoubtedly of great advantage in much of the diversified work of the general contractor. On the other hand, motor trucks are already being utilized for a great variety of work, much of which, such as the hoisting and dumping of heavy loads, being of a kind not usually obtained from horses. Another argument put forth by Mr. Crane was that there is always a market for a horse, which is not true of second-hand auto trucks. On the other hand, horses die and suddenly become a total loss, and it would seem that if the contractor is getting results and is in business to stay he need not worry about Mr. Crane's objection.

The value of cost data and the ability of the average contractor to understand them brought forth decided differences of opinion. Doubts were expressed as to the reliability of cost data given out on motor trucking, the opinion being that if contractors were getting good results they would not give them to competitors. Be this as it may, there is no doubt that even though the figures are conscientiously prepared many of them are unreliable because incomplete, in that they neglect important modifying factors. For instance, as was pointed out in the discussion, ton-mile costs that fail to take account of grades or road conditions do not mean much. Moreover, published comparisons between motor trucks and horses doing the same work are apt to be of small value owing to the omission of data on horse-drawn traffic, regarding which cost statistics are generally wofully inadequate. Furthermore, a considerable part of the cost data published fails to convince on account of small errors and discrepancies, which give the impression that the material was put together hastily by people who scarcely understood it, instead of carefully by accountants and technical analysts. There are contractors who scoff at carefully analyzed cost data and others who are thoroughly alive to their value. The latter, too, it will be found, are the ones who are always on the lookout for new equipment and methods. Only they are likely to use motor trucks successfully. They will want cost data of a thoroughly reliable sort and will demand that the equipment be adapted to their particular needs. This class of contractors has already gone into motor trucking on a considerable scale and will continue, when the real possibilities and the limitations are clearly shown, to extend the uses of trucks to other work. It is unlikely, however, that all the horses will be replaced either now or for some time to come, for there are places in which their use is undoubtedly economical.

Recent Development in the Brick-Paving Industry

Within the last three years those who have followed the brick-paving industry have seen a strong movement to return to a type of brick used years ago and abandoned because of an accidental rather than intrinsic defect. The wire-cut block, originally used, was superseded because of the difficulty of securing uniform spacing in the pavement, and repression was adopted principally for the purpose of forming the spacing lugs. With the advent of a block having wire-cut lugs the former advantages of the repressed type have largely disappeared, while its disadvantages have been thrown into relief.

As the situation was expressed by an engineer who after a thorough study recently specified wire-cut lug blocks for a large job, the very logic of the new type, aside from any actual experience in the road, is in its favor. The repressing adds nothing of real value except the lugs. These can now be formed, and with absolute uniformity, on the wire-cut block, while the square corners and the rough sides are advantages not found in the repressed type. At the same time the intensification of the laminations, an accompaniment to a greater or less extent of repressing, is avoided.

Tests of the new blocks in service have so far borne out the theoretical considerations, but the results in the rattler, while reported to be not less favorable to the wire-cut than to the repressed blocks, warrant more careful study. It is worthy of note that although the use of the new brick has increased rapidly since it was introduced three years ago, no special provisions as to abrasion allowance for either wire-cut or repressed brick are included in the tentative specifications offered for consideration by the committee on specifications for brick of the American Society for Testing Materials at Atlantic City last month. It would seem that the matter is worthy the consideration of the committee, if it has not already received attention.

The present status of the wire-cut block is indicated by the fact that one-third of the manufacturers of paving brick, producing 53 per cent of the total output, are now equipped to manufacture the wire-cut product, and it is estimated that about one-sixth of the present yardage is of the new type. The increase in its use should be rapid, but will naturally be checked by the inertia experienced in changing from any well-intrenched product. This is particularly true when laymen (who frequently pass on paving material) are to choose between a rough, apparently carelessly made article, whose intrinsic merits are not shown by surface indications, and a smooth, attractive material. It is in this situation that engineers, fortified by investigations as to intrinsic value, need to exercise their influence.

Utilizing Standard Equipment

In the applications of electrical apparatus to industrial and central-station service the temptation is always present to specify equipment differing in perhaps only a few particulars from those established lines of product which the manufacturers consider as standard. A moment's thought is enough to convince one that the lowest selling prices on lamps, motors, regulating devices, transformers or other electrical equipment depend upon the extent to which such apparatus can be utilized by everybody in the field, and it is unnecessary to emphasize here the cost of complications in the factory. It is difficult, however, for anyone who has not been concerned with manufacturing processes to realize fully the total waste of effort, the losses in designing cost, the demands on manufacturing and engineering information and the chances for error in production which follow even apparently insignificant differences in specified appliances and machinery; but engineering common sense tells one that the production of duplicates is cheaper in the long run than the manufacture of special products.

In purchasing transformers, for example, there is no doubt that one of the chief drawbacks from the manufacturer's point of view is the tendency of individual operating companies to specify different arrangements of taps. As pointed out by Mr. H. H. Rudd at the recent National Electrical Lighting Association convention, one company desires one arrangement; another wants something else—not very different, but yet enough so to make it impossible for the manufacturer to use stock designs and stock parts. The transformer's flexibility as a piece of apparatus makes it a sort of plaything in the hands of many engineers. The manufacturer, in order to standardize production, desires to cut all complications from the design, while the central station or the power user desires a variety of taps, so that the transformer can be used for any and all conditions through a big range of operation. Now, in a matter of this kind there is much in favor of the manufacturer's point of view. It is probable that in nine cases out of ten transformers having certain high-tension voltage and taps and certain low-tension voltage and taps could be agreed upon as standard without injury to anyone, resulting at once in quicker deliveries and eventually in lower prices. The space taken by a multiplicity of taps and complicated terminal boards requiring the best sort of insulation needs to be eliminated to make the first cost low and high voltage distribution on a small scale practicable.

It is equally important, of course, to realize that without the production of special apparatus the art would never advance, and there are times and seasons when sound engineering reasons can be shown for specifying equipment entirely different from that previously employed. Where practice can be improved is more along the lines of avoiding slight and comparatively unimportant changes from established and well-tried forms, once the purchaser's engineer is assured that these well-known products will do the work well enough. New men are often tempted to write more or less eccentric specifications in the belief that if they follow the beaten path their employers will obtain unfavorable impressions of their intellectual independence. That is not the way to look at such matters; the real issue is to get the best results warranted by the cost; and the wise engineer will always try to make "standard" apparatus fill his requirements before branching out into the fascinating but expensive pursuit of designing and buying unusual equipment.

Cleveland's New Charter

The new charter adopted by the voters of Cleveland on July 1 is an indication of the influence which the commission-government movement is exercising even on the larger cities. While the small combined legislative and administrative body is rejected, the short ballot, non-partisan at the same time, is carried to its limit, responsibility is very definitely fixed, and the recall, a usual but not an essential accompaniment of the commission form, is adopted. The new charter marks another advance toward perfecting municipal administration in this country and should, therefore, be of interest to engineers, who are ever taking a larger part in municipal activities, even aside from purely engineering work.

The fundamental idea of the new charter is the so-called "federal" plan of government, wherein all municipal authority, other than judicial, is vested in an elective council and an elective mayor, the former having all legislative powers and the latter all administrative powers. These two main functions are thus separated, and throughout the document are provisions against the interference of the council or its members in administrative affairs. The reverse also holds—that the executive is divorced from the legislative division, though the privileges of advising the council and of veto are reserved. This responsibility is definitely fixed—the council being accountable for the adoption of policies, the mayor for their enforcement.

According with this sharp differentiation of function and with this definite fixing of responsibility is a ballot system—the shortest of the short—which conduces to a close scrutiny of the candidates for office. Only the mayor and the councilmen will be elected, the latter, one from each of the twenty-six wards, by the ward vote only, and not "at large." Preferential voting will be allowed, each voter designating, if he desires, not only a first, but also a second choice, and even "other choices," and, finally, the recall is provided to "insure responsiveness to public opinion."

Aside from the centralization of responsibility, in itself a most desirable feature, there is much in the general scheme of organization to commend itself to seekers after municipal efficiency. The executive work is divided among six main departments, each with a head or "director" appointed by the mayor. These departments are law, public service, public welfare, public safety, finance, and public utilities. The director need not be a civil-service appointee, nor a specialist in the work of his department or of one of its branches. Within the departments will be divisions, each under a commissioner appointed from the civil-service lists. It is intended that the commissioners shall be the expert higher officials, who will remain in the service through successive administrations and be the heads of a stable, specialized administrative organization.

A unique and highly commendable feature relating to the work of the division is the power vested in the director of appointing an unpaid advisory board to counsel with a given commissioner. The idea has been applied abroad and is not intended to enable expert advisory services on a fee basis to be dispensed with, but to give official standing to committees of professional and business men whose judgment and advice are considered valuable and whose constant interest and suggestions as to their specialties cannot help but bring about higher standards in municipal affairs. Instead of leaving civic bodies, as is generally the case, to force the services of their committees on the city officials it will, by giving these advisers a definite status, make it incumbent on the part of the officials to seek such assistance.

With the exception of building inspection and housing inspection (sanitation), which are under the director of public safety, the engineering duties are performed by the department of public service. The subdivisions are streets, embracing maintenance and operation and including sewers, garbage disposal, wharves and bridges; parks and public grounds; engineering and construction, and franchises, the last named including the supervision of all privately owned and operated utilities. The head of the division of engineering construction, known as the commissioner of engineering, will be the chief engineer of the city and will be the deputy director of public service.

Among the innovations following the lead of well-administered foreign cities and putting into effect, backed by law, plans discussed and commended, but seldom acted upon in the United States, are the establishment of a special department for the sole purpose of promoting the physical well-being of the citizens and of a city-plan commission—with real powers, as distinguished from the usual advisory functions. In the department of public welfare will be divisions of health, charities and corrections, public recreation, employment, and research and publicity, the last mentioned to be vested with the duty of making researches into the causes of poverty, delinquency, disease and other problems of the community, and of disseminating information regarding them by lectures, exhibits and other means. The city-plan commission's control will extend to the design and location of works of art, public buildings, harbor works, bridges, street fixtures and other structures, the location and extension of streets and parks and the preparation of plans for the future physical development and improvement of the city.

In addition to the departments above enumerated there will be a special bureau of information and publicity under the direct supervision of the mayor, which will be charged with the duty of collecting data regarding municipal administration, putting them in readable form and supervising their dissemination.

Finally, all but sixty employees of the city will be under civil service, whereas at present about fifteen hundred are in the exempt class. Promotion on merit is to prevail, and with this end in view a system of efficiency records is to be established.

It is apparent from this brief review that the new charter is a decided advance in many directions over the fundamental documents of council-governed cities. From theoretical considerations it indicates that cities too large to apply the commission system in all its simplicity can still go far, without discarding the council system, toward definitely fixing responsibility and promoting municipal efficiency. How the new plan will work cannot be foretold, but the system of responsibility provided augurs well for its success. That the plan has defects is conceded by those who have studied it carefully, but the apathy of the citizens (only 36,000 out of 97,000 voters cast a ballot on July 1) indicates the confidence felt in the charter commission's work and their general approval of the document. It warrants study by those interested in the improvement of American municipal government, and as encouragement for such study it is not amiss to remark that the document covers but sixty pages, probably the smallest charter of any city of considerable size in the country, and certainly the briefest of any city approximating Cleveland in population.

New Iowa Road Law

The recent change in the highway laws of Iowa, briefly summarized on page 36, is significant of the new attitude toward highway construction throughout the United States. The supervision of the development and maintenance of Iowa roads, costing $7,500,000 per annum, was, under the former highway law, largely in the hands of farmers and tradesmen who were without direction and unfamiliar with the technique of road construction. Their public duties as road supervisors were secondary to their private interests. The results were just what might have been expected—large sums were wasted annually.

The new law differs radically from much recent highway legislation in that it does not grant state aid and avoids the idiocy of long-term highway bonds. The new highway board has supervisory functions only, but of such a character as presages successful work. Each county applies the funds from its own assessments to roads within its own borders, thus stimulating the personal interest of the people in the efficient expenditure of their money. The correlation of these roads into a state system is to be secured by the supervisory and veto powers of the highway commission, but the responsibility for the selection of an engineer to design, construct and maintain the roads rests upon the shoulders of the county board of supervisors.

Especially important is the exclusion of bond issues, already referred to, and the limiting of expenditures to funds raised by assessment. In this respect, in particular, the law deserves to be copied far and wide. Iowans have the satisfaction of knowing that even if the original roads disappear in 15 years they will not be left with 35 years of interest and sinking-fund charges to embitter the remembrance.

There is one respect, however, in which the law is disappointing — it gives the state highway commission no supervision over maintenance. So much emphasis has been placed on the subject in recent years that one would expect adequate maintenance to be provided for in a law so well thought out as to other particulars as the Iowa legislation. As the measure stands, however, maintenance is left entirely with the county officials, and with them, therefore, will rest ultimately the value of the roads no matter how excellent the personnel of the highway commission or its control over design and construction.

The provisions as to township roadwork are also of more than passing interest and deserve the attention of those who follow the development of highway legislation.

The law is a good step forward, and it is to be hoped that future amendments will widen the scope of the commission so as to give it control over maintenance as well as over design and construction.

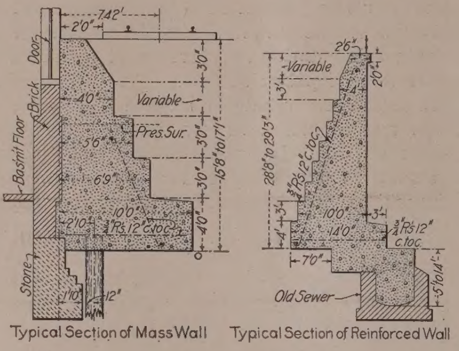
Grade-Crossing Elimination at Second Avenue and Try Street, Pittsburgh

Improvements Embodying Several Types of Masonry and Bridge-Floor Design

The tracks of the Southwest system of the Pennsylvania Lines West of Pittsburgh curve to the southwest upon leaving the Pennsylvania Station at Pittsburgh and pass through a double-track tunnel under the so-called "Hump." Emerging from the tunnel at Forbes Street and the Fourth Avenue Station, they continue about 1100 ft. to the bridge that carries them over Water Street and the Monongahela River. Crossing the tracks at grade, before the present improvement was begun, was Second Avenue, an important thoroughfare carrying two tracks of the Pittsburgh Railways Company. Buildings close to the tracks obstructed the view and made the crossing a dangerous one.

First Avenue was closed, but as the Baltimore & Ohio Railroad had acquired property and proposed to build a freight house and an extensive team yard east of the tracks of the Pennsylvania Lines, the Pennsylvania company agreed to construct a bridge at First Avenue to afford access to the freight house and team yard. Southeast of the tracks the narrow roadway at Try Street descended from Second Avenue to Greenough Street on about a 5.5 per cent grade, which, without the First Avenue bridge, would have been the principal access to the Baltimore & Ohio Railroad team yard.

To eliminate the Second Avenue grade crossing it was practically out of the question to carry the avenue overhead, as it was largely built up with brick blocks and there was not room enough between the tracks and Ross Street for an approach grade. The short space between the tunnel and the Monongahela River bridge made it impossible to change the grade of the tracks to any great extent. By beginning at the station, however, and raising the tracks on a 1 per cent grade as shown, and carrying this grade to an intersection with the level grade of the main span of the river bridge, thus taking out a sag at Second Avenue, it was found possible to raise the tracks at each of the crossings about 6 ft. and carry the avenues under. This incidentally necessitated raising the short spans across Water Street and the Baltimore & Ohio Railroad tracks a maximum of 3.39 ft. to the level of the main span across the river.



Typical Section of Mass Wall Typical Section of Reinforced Wall

Plain and Reinforced Wall Sections

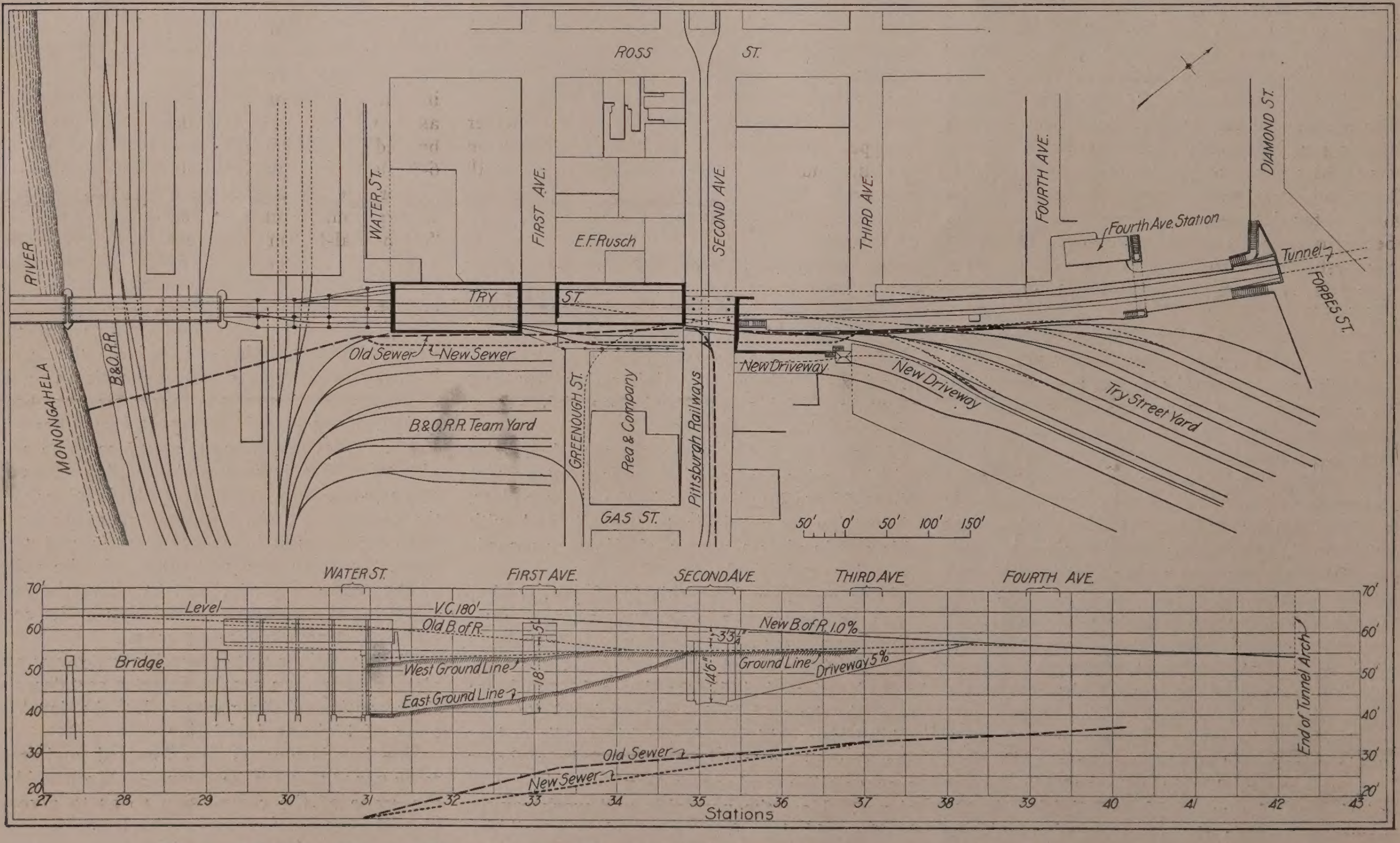
Street Profiles

The street profiles were determined largely by the necessary depression of Second Avenue to give an underclearance of 14½ ft. to allow for the passage of trolley cars and the minimum feasible floor depth of 3 ft. 3¼ in. The new grades of First Avenue and Greenough Street were established low enough to afford easy access to the Baltimore & Ohio team yard, the new grade of the Try Street roadway descending from Second Avenue on a grade slightly in excess of 2 per cent. This brings the level of First Avenue nearly 23 ft. below that of the tracks, affording an abundance of underclearance and floor depth.

The approach grades were established by the city and the street work is being cared for by the city and the street railway company. The northwest approach of Second Avenue was given a 5.425 per cent grade to make it run out at Ross Street. The other approach closely parallels the old grade 10 or 12 ft. below it on a 3 per cent grade, finally running out beyond a summit 1200 ft. from the tracks. First Avenue is to be given a grade of 4 per cent descending from Ross Street. The grades of the other streets affected are materially lightened.

As may be seen from the general plan, the track layout at the entrance to the Try Street team yard has been revised and an additional track parallel with the main tracks provided as a switching lead for this yard. This arrangement makes it possible to do all the yard switching without using the main tracks and has permitted the extension of the eastbound station platform to Second Avenue, where connection is made with the street by means of a stairway. In order to carry this switching track and restore sidetrack facilities to Rea & Company, Try Street is roofed over between Second and First Avenues and two short spurs leading from the switching track are provided for Rea & Company on this bridge.

To make the switching lead for this yard still longer, it is carried out over several approach spans of the river bridge, which is widened for the purpose. This bridge is similarly widened on the other side to allow a trailing switch to the sidings on that side to replace the old facing switch near Second



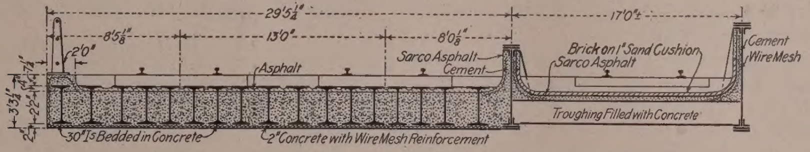
Plan and Profile of Tracks, Showing Streets Involved, Outlines of Bridges, and Old and New Tracks and Sewers

Progress View Looking Up Try Street from Greenough Street

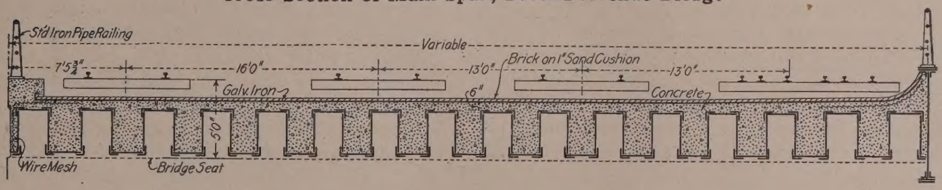
Avenue. In addition to widening and raising this bridge, another span has been put in to open up Water Street to its full width.

As the general plan shows, numerous retaining walls were necessary to hold the embankments along Try Street and the Baltimore & Ohio team yard and along the industrial plants on the opposite side of the tracks. Two different types of retaining walls have been used, a typical section of each being shown. The mass wall without coping is used on the northwest side, where the distance from center of track to right-of-way line is small and the wall is built right against the walls of the existing buildings. The wall is fitted to the old building walls, as shown, for the reason that the railroad company deemed it advisable to occupy as much of its right-of-way as possible to avoid possible future disputes as to the ownership of the land in case the existing buildings should be torn down. The row of concrete piles, which are spaced 3 ft. center to center and are 30 ft. long, precludes the probability of excessive pressure coming on the footings of the old buildings. It may be said that the old walls are as irregular as shown only for a short distance; in general the face of the new wall is plumb, with little or no bearing on the old wall, and the concrete piles are 1 ft. 6 in. from the face of the top of the wall instead of 2 ft. 10 in., as required at this point.

On the southeast side of the tracks, where a much higher wall was required, the thinner section was used, with the reinforcing rods running all the way up and a coping at the top. As shown on the general plan, a 6-ft. brick-and-stone sewer ran just outside of the line of the face of the proposed wall, the top being in general a few feet below the elevation established for the bottom of the wall. After this sewer had been replaced by a somewhat larger one of reinforced concrete, farther from the tracks and lower down, the old sewer was utilized as a footing for the retaining wall by removing the top and filling the sewer and the intervening space with concrete, as shown.



Cross-Section of Main Span, Second Avenue Bridge



Cross-Section of First Avenue Bridge near Southwest Abutment

BRIDGE FLOORS

Owing to the different conditions respecting spans and floor depths for the bridges, five different types of bridge floor have been used. Columns on the curb line divide the part of the Second Avenue bridge carrying the main tracks into two short spans and an intermediate one of 43 ft. 1⅛ in. To keep the floor depth to a minimum as required, 30-in. longitudinal I-beams were used as shown in the cross section, the ties being laid immediately on top of the beams. It will be seen that the I-beams are embedded in concrete except for the top 4 in., where asphalt is used for waterproofing, with a gutter in each space between beams. For the short spans 15-in. longitudinal I-beams were used, and in the trapezoidal part of the bridge carrying the siding transverse troughing between girders was used. In each case the steel was bedded in concrete and covered with a 3-in. layer of it, on top of which was placed the waterproofing as shown, consisting of a coating of "Sarco" asphalt, furnished by the Standard Asphalt & Rubber Company of Chicago, with a layer of brick on a 1-in. sand cushion on top of that. This still left room for several inches of ballast under the ties.

At the First Avenue bridge and the roofing over Try Street where the floor depth was in no way cramped galvanized iron was made use of in the waterproofing. As shown in the cross-section, the First Avenue bridge has a floor depth of 5 ft., the floor being carried by longitudinal troughing filled with concrete and covered at the top with concrete to a depth of 6 in. The top surface is coated with "Arco-Seal-It," furnished by the Atlantic Refining Company, and on top of this is laid No. 24 gage galvanized American ingot iron in flat sheets with riveted and soldered joints. The top surface of the iron is then given a coat, 1/16 in. thick, of "Arco-Seal-It." On top of this a 1-in. sand cushion is spread and on this is a layer of brick, with the joints filled with tar. At the abutments the galvanized iron and the brick are curved around the end of the steel and carried back of the coping to the bottom of it.

The Try Street bridge has a floor of 30-in. transverse I-beams, the inner end carried by the retaining wall (which is immediately under one of the tracks) and the outer end resting on longitudinal girders carried by columns as shown in the general plan. The beams are bedded in concrete and covered on top with a 6-in. layer, the waterproofing being the same as for the First Avenue bridge, except that waterproofing pitch is substituted for the "Arco-Seal-It" on both sides of the galvanized iron. This bridge has a floor depth of 4 ft.

Progress View of Second Avenue Crossing from Southeast Side

4 in. Its outer edge is on the right-of-way line, the center of the outside track being 5 ft. 9 in. from the right-of-way line. The edge is protected by a standard iron pipe railing on a concrete curb.

Personnel

This improvement is being carried on under the supervision of Mr. W. C. Cushing, chief engineer maintenance of way of the Southwest system of the Pennsylvania Lines West of Pittsburgh. Mr. E. E. Stetson, assistant engineer, is in immediate charge of the work. The concrete masonry work was built by the John F. Casey Company. The concrete sewer was constructed by the Cranford Construction Company, of Pittsburgh. The steel was furnished by the Ft. Pitt Bridge Company, of Pittsburgh, and erected by the railroad company's forces. The street work, as previously stated, was taken care of by the city and the Pittsburgh Railways Company.

Electrolytic Corrosion of Iron in Soils

The Bureau of Standards for some time past has been investigating the subject of electrolysis and electrolysis mitigation. Part of the work has consisted of a study of electrolytic corrosion of iron in soils, and it was this phase of the subject which was dealt with in a paper presented before the thirtieth annual convention of the American Institute of Electrical Engineers, June 23-27, by Messrs. Burton McCollum and K. H. Logan. The paper set forth the fundamental laws governing electrolytic corrosion of iron in soils and discussed experimental data showing the effect of the factors most likely to influence corrosion of buried pipes under practical conditions, such as current density of discharge, moisture content of the soil, presence of oxygen, temperature, voltage and other considerations. The conclusions reached by the authors are summarized below. The results are expressed in terms of the "corrosion efficiency." If the corrosion of the anode is the sole action involved at the anode then according to Faraday's law 96,540 coulombs are required to corrode one gram-equivalent of the metal and the corrosion efficiency is said to be 100 per cent. In most cases, however, the actual corrosion noted is either greater or less than this amount and the percentage which the actual corrosion in any case is of the theoretical amount is called the "efficiency of corrosion" under those conditions.

Conclusions

The current density has a marked effect on the efficiency of corrosion of iron in soils, the efficiency of corrosion being in general greater the lower the current density. In saturated soils the corrosion may vary between 20 and 140 per cent for the range of current densities between 5 and 0.05 milliampere per square centimeter.

Moisture content in the soil also has a marked effect on efficiency of corrosion. The corrosion efficiency in general is greater with increasing moisture content up to saturation of the soil. Beyond this point increased moisture content has comparatively little effect.

Temperature changes within the limits commonly met with in practice have no important effect on corrosion efficiency.

The depth of burial of pipes has no direct effect on corrosion efficiency provided other conditions remain constant. In practice, however, the moisture content, current carried by the pipes, and various other factors which affect corrosion efficiency will vary with depth so that, indirectly, differences due to depth may be noted.

The amount of oxygen present has no appreciable effect on the efficiency of corrosion in the case of iron immersed in liquid electrolyte.

Corrosion efficiency of iron embedded in earth is always greater in open vessels than in sealed vessels.

The amount of oxygen present has a marked effect on the end products of corrosion. If the corrosion is rapid and the supply of oxygen small there will be a preponderance of magnetic oxide, while if the rate of corrosion is low and the supply of oxygen abundant the ferric oxide will predominate. Owing to the fact that the supply of oxygen around pipes buried in earth is always more or less limited, the character of the oxides formed gives some indication as to the rate of corrosion, and thus indirectly as to the cause of the corrosion, if local conditions are properly considered.

There is no material difference in the efficiency of corrosion shown by the various kinds of iron commonly used in the manufacture of underground pipes.

The fact that a given chemical tends strongly to inhibit either self-corrosion or electrolytic corrosion in liquids is no indication that it will materially retard electrolysis of iron embedded in soils.

Pitting of iron embedded in soils is affected not only by a non-homogeneous condition of the iron or soil, but also by the chemicals contained in the soil.

The efficiency of corrosion was found not to be a function of the voltage except in so far as the current density may be effected. Voltages as low as 0.1 and 0.6 showed practically the same efficiency of corrosion as 5 to 10 volts or higher.

Corrosion tests on a large number of different kinds of soil from widely different sources, with average moisture content and moderate current density, indicate that corrosion efficiencies between 50 and 110 per cent may usually be expected under most practical conditions.

The resistance of soils varies throughout a very wide range with variations in moisture content, the resistance of the comparatively dry soil being of the order of several hundred times the resistance of the same soil at about saturation. Above saturation increase in moisture content has but little effect on the resistance of the soil.

Because of the great variations in resistance of earth with moisture content voltage surveys should not be made at times when the earth is extremely dry.

The resistance of the soils varies greatly with temperature within the ordinary range encountered in practice. In the case of the soils tested the resistance at 18 deg. C. below zero was over two hundred times as great as at 18 deg. above zero. Even at about freezing temperature the resistance will be several times that at summer temperatures. This not only has an important bearing on the magnitude of the electrolysis trouble that may occur at different seasons, but it also indicates that where practicable voltage surveys should not be made when extremely low temperatures prevail.

The experimental results given in the paper, according to Messrs. McCollum and Logan, have an important bearing on the subject of electrolysis mitigation through the limitation of voltage drop in the negative return. For some years the chief means of preventing trouble from electrolysis in certain foreign countries have been the limitation of the permissible voltage drop between any two points on the return circuit. In some places the limit has been placed on the maximum voltage during peak load, whereas in other cases the average voltage for twenty-four hours has been the determining factor. It will be evident that if the total amount of damage which results is proportional to the average current, then the limitation of the average voltage would be more logical than the limitation of the peak-load voltage, since in the former case the cost of meeting the voltage limitation in any given case would be proportionate to the danger involved irrespective of the station load factor; whereas if the voltage at peak load is the determining factor, the cost of complying with the requirements depend not only on the danger involved but on the load factor of the system, and the poorer the load factor the greater its cost will be. It appears from the data presented in the paper that the rate of damage does not increase as fast as the voltage increases, because of the tendency toward lower corrosion efficiencies at higher current densities. This indicates that, with a given average all-day current, the actual amount of electrolysis that would occur would be less with a bad load factor than with a good load factor, and hence points to the undesirability of penalizing a high peak of short duration. It would appear very much more logical, therefore, in so far as the damage itself is concerned, to make the average all-day voltage the basis of the limitation rather than the voltage at time of peak load.

Discussion

In discussing the paper Prof. D. C. Jackson remarked that the authors presented only in part the results of the researches carried on at the Bureau of Standards. In his own experience he found that soil resistivity is a more important factor than moisture content. Thus corrosion differs greatly for the same voltages with different soil conditions, as found in different localities. Concrete roadbed construction usually holds much moisture and is thus conducting to a considerable degree. The effect of temperature is important, and frozen earth lessens the stray current flowing in metal structures beneath. In experiments made in 1894 he found corrosion in the presence of a single acid radical to be much less than that predicted by Faraday's law. Cast iron corrodes less rapidly than does wrought iron, perhaps due to the impeding action of the carbon and manganese present. When the earth around a pipe is frozen the conductivity is greatly reduced, which he found to be the case from the close agreement between actual and calculated current values required to thaw ice in water pipes. It is not the peak current in electrolysis which is important, but the average. The real problem now pressing for solution is how far to go to strike a cost balance between the damage done and the cost of preventing it.

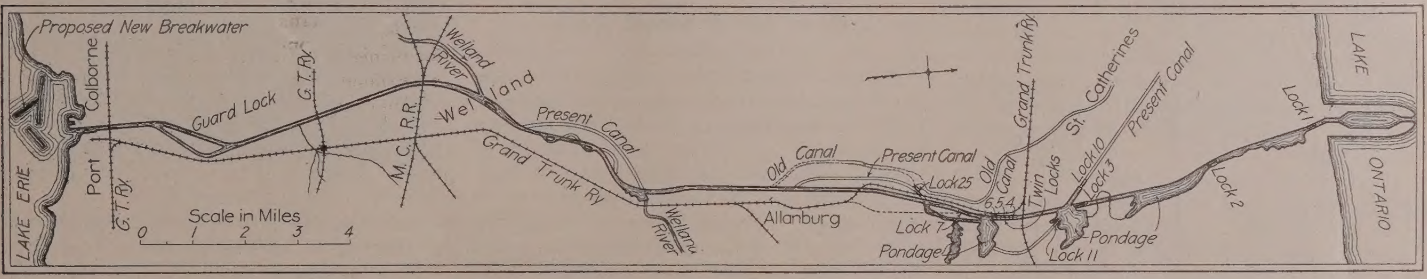
Prof. A. F. Ganz said that the paper proves the practical value of Faraday's law, which gives about 20 lb. of iron lost per ampere-year. Very excessive apparent efficiencies of corrosion, as high as 500 per cent, were obtained by him only where the surface skin of the pipe had not been removed. Where the pipe had been turned off he found corrosion efficiencies of from about 100 to 120 per cent. There is unquestionably a variation of efficiency with the current density. But the damage increases where corrosive action is nonuniform and pitting occurs, and the pipe shell will be pierced much sooner than otherwise.

In closing the discussion Mr. McCollum said that the passivity of iron is due to a number of different causes. For instance, it is passive in fuming nitric acid. He agreed that high earth resistance is an important point, but said that high resistance and low moisture content generally go together. Faraday's rule as originally stated is applicable only to the electrolyte, but it still holds also for the anode reaction. There is undoubtedly less leakage, he said, when the earth is frozen. It is not necessary to eliminate corrosion entirely, but only to reduce it to the economic maximum limit. Pipe coatings he did not in general approve of, as they are likely, through defects, to augment corrosion at local points. Pitch, although expensive, he said, is an effective coating. Alternating-current electrolysis, even at very low frequencies, amounts to only a fraction of 1 per cent of the amount that occurs with direct current. He commended the use of return or negative feeders and said that insulated pipe joints are useful only as an adjunct remedy.

Proposed Welland Ship Canal

General Features of the Plan Adopted, Which Includes in Part an Enlargement of the Present Canal and in Part an Entirely New Location

As finally located the enlarged Welland ship canal will conform closely to the route of the present canal from Lake Erie to Allanburg, a point about midway between Lakes Erie and Ontario. From Allanburg an entirely new location will be followed. This will cross the present canal twice, finally reaching Lake Ontario at the foot of Ten Mile Creek—3 miles east of the present terminus at Port Dalhousie. The total length will be 25 miles. The fall of 325½ ft. will be accomplished by seven locks, each having a lift of 46½ ft. Each lock will be 800 ft. long and 80 ft. wide, with a minimum depth of water over miter sills of 30 ft. The canal will be 200 ft. wide at the bottom, designed for a depth of 30 ft., but excavated for only 25 ft. for the present. This will permit dredging out the remaining 5 ft. at any future date.



Route of Proposed Ship Canal, Showing Its Relation to Present and Old Canals, and Location of Main Features of Interest

At Port Colborne, the Lake Erie terminus, a new breakwater will be built on the west side of the entrance to insure quiet water in the harbor during storms, the present breakwater being insufficient for the purpose. The new breakwater will consist of an immense rubble mound of stone from the excavation north of Port Colborne, and will terminate in a timber-and-concrete headblock located some 2000 ft. farther out in the lake than the present breakwater.

Harbors at Port Colborne

The outer harbor at Port Colborne now has a 22-ft. depth of water at ordinary stages of the lake, which is as much as is available at most of the other lake ports and in the channels connecting the lakes at the present time, and the deepening of this portion of the harbor may be left for a few years until the connecting channels in the lakes allow deeper navigation. The inner harbor will be excavated to the new depth, and the old locks and regulating weir now in the center of the village will be entirely removed.

From Port Colborne to Humberstone the rock cut will be deepened and widened on the west side, and just below Humberstone a new cut will be made across the point now forming Ramey's Bend, materially straightening the canal. The spoil from this cut will be nearly all rock, and will be used to form the breakwater previously mentioned. A guard lock will be built in the rock cut a short distance below Humberstone, and when this new cut is ready for navigation a regulating weir will be built across the abandoned portion of the present canal, which will be used as a by-pass to furnish water to the canal. This lock and regulating weir will control the elevation of the summit level of the canal; it is proposed to keep this at the level of extreme low water in Lake Erie, which is 568 ft. above sea level.

Utilizing of Welland River

From Ramey's Bend to Welland the canal will be deepened and widened by excavating a strip along the western bank. The present canal is carried over the Welland River at Welland by an aqueduct, but instead of building a new aqueduct it is proposed to raise the level of the river to that of the summit level of the canal by means of a dam across the river at Port Robinson. This dam will be provided with a large overflow and regulating weir, which will control the elevation of the summit level, allowing any surplus water to overflow into the old Welland River and pass out into the Niagara River at Chippawa, as at present. A sufficient quantity of water will be allowed to run constantly to keep the river clean.

The present aqueduct at Welland will be dredged out, as well as the bank between the canal and the river. The river will be utilized between Welland and Port Robinson instead of the present canal, being somewhat more direct and entailing considerably less excavation. At Port Robinson a cut will be made through the present bank between the canal and the river, enabling vessels to re-enter the canal prism. Between Port Robinson and Allanburg what is known as the "Deep Cut," which has a maximum depth of 66 ft., will be enlarged by cutting a slice off the western bank.

In raising the Welland River above Welland some 1600 acres of low land adjoining the river will be flooded. This land is not of any great value, as it is flooded every spring by the overflow of the river, and is used chiefly for pasturage. The township of Wainfleet, adjoining the Welland River on the south side, consists principally of low-lying ground which drains into the Welland River, and to prevent damage to this land on account of the raising of the river it will be necessary to open up most of the ditches from the point of their present entrance to the river to the intended high-water mark.

Turning the Welland River into the canal will pollute the waters which are at present used by the towns of Welland, Thorold and Merritton and the city of St. Catharines for domestic purposes. This may necessitate the construction of extensive filtering plants, although this scheme is not looked upon with favor by those interested. An alternative scheme to lay a pipe line from Lake Erie to the reservoirs of the different municipalities, through which clean water would be continuously pumped, is under consideration and appears to be the most feasible scheme available.

Protection of Water Power

From Allanburg it will be seen from the map that there are already two canals, known as the old and present canals. The former is utilized for numerous water-power developments, water being let into it from the present canal by means of a weir at Allanburg. In connection with the construction of the ship canal it is proposed to close the old canal entirely between Allanburg and Marlatts bridge near Thorold, first building a new weir at the head of lock 25 of the present canal to supply the necessary water for the old canal below that point. A dam will then be thrown across the old canal at Allanburg, and the old canal bed between the dam and Marlatts bridge will be utilized as a dumping ground in which to place the material removed from above water level in widening the deep cut. This will form a convenient dumping ground, and the old canal will become more self-contained, as at present the entrance works are situated at an inconvenient distance from the remainder of the canal.

If it is desired to continue navigation on the old canal, entrance may be had to it through lock 25 of the present canal when the ship canal is completed by making a short cut through the bank separating the two waterways.

Upper Locks

A pair of twin guard gates will be located on the proposed canal near the southerly limits of the town of Thorold, and a short distance north of them lock 7 will be built, the head of this lock being directly opposite the head of lock 24 on the present canal. That portion of the present canal between locks 25 and 24, together with a pond of about 27 acres formed by flooding the upper valley of the Ten Mile Creek, will be utilized as a regulating basin from which water to fill lock 7 will be drawn. This method of drawing water from a side pond instead of directly from the canal above avoids the formation of objectionable currents and surges in the canal and locks, and is the method adopted for filling all of the locks.

Below lock 7 will be a short reach of canal with an adjacent side pond or regulating basin having a surface area of about 84 acres, and immediately below will be located locks 6, 5 and 4 in flight. These three locks will overcome a descent of 139½ ft. They will be twin locks, one flight being used for down-bound vessels and the adjoining flight for up-bound, a double flight being required to save long delays in the passage of vessels through the canal.

The main line of the Grand Trunk Railway between St. Catharines and Niagara Falls will cross over the foot of twin locks 4, by means of two short bascule lift bridges. The Welland division of the railway is situated just where the new locks are to be built, and it will be necessary therefore to divert it some distance to the west. The relocated line will bear the same relation to the proposed canal as the present line does to the present canal, following up on the west side of the locks; it will remain on the west side of the canal for some distance above the present lock 25, and then cross the proposed canal on another bascule lift bridge.

Lower Locks

From lock 4 the proposed canal will cross the meadow to the north, following in part the bed of the Ten Mile Creek until it crosses the present canal at the foot of lock 11, at an elevation of 382 ft. above sea level. This is the level of the present canal at that point, and small vessels will be able, if desired, to use the Port Dalhousie entrance as at present as far as lock 11.

Lock 3 will be located immediately north of the present canal, and at its head on the east side will be situated an equalizing basin or pond of 150 acres. Below lock 3 a heavy cut will be required through the village of Homer to a point where the bed of Ten Mile Creek is again reached, and below this point lock 2 will be built. It was difficult to find a location for this lock on account of the lack of rock for a foundation, but eventually a suitable foundation was found at the present site. The canal at the head of lock 2 will be at an elevation of 335½ ft. above sea level and will flood about 200 acres of land along Ten Mile Creek. Below lock 2 the canal will follow the bed of the creek to the lake, lock 1 being situated just below the Lake Road. The pond at the head of lock 1 will cover an area of 107 acres.

Lake Ontario Entrance

The outer entrance piers in Lake Ontario will be about 1½ miles from shore, where the depth of water is 30 ft. A wide channel will be dredged from these piers to lock 1. The sides of this channel will be protected near the shore end by reinforced-concrete cribs with concrete superstructure, alongside which vessels may lie. From the shore line of the lake to the outer entrance piers an embankment about 500 ft. wide will be formed on either side of the channel from material excavated from the canal between the lake and Thorold.

For the purpose of conveying this material from the different contracts to the lake the Department of Railways and Canals will build a double-track railway along the west side of the canal from the foot of the flight locks near Merritton to the lake, and temporary trestles from which to start the dumps will be built out into the lake on either side of the harbor. The railway will also be utilized to haul crushed stone from the site of the flight locks to locks 1, 2 and 3, where it will be used for the purpose of making concrete. The contractor for the rock excavation from the site of the flight locks will, under his contract, be obliged to crush a sufficient quantity of the good rock taken from his excavation to supply all the stone required in concrete for the locks and other structures.

Lock Details

The lock walls will be 82 ft. high above the top of the gate sills, and including the necessary foundation work required below this level two of the locks will have walls 100 ft. high. The lock gates will be of the single-leaf type, swinging on a hinge at one side of the lock and resting in a notch cut in the opposite wall, a single leaf thus spanning the whole width of the lock chamber. The gate at the foot of each lock will be 83 ft. high and 88 ft. long, and will weigh about 1100 tons. The valves and culverts in the walls will be of large dimensions and will permit of the lock being filled in less than eight minutes. This will mean that the time of passage through the canal will be reduced much below that required at present.

The work will be done under the direction of the Department of Railways and Canals of the Dominion Government. Mr. J. L. Weller is the engineer in charge.

New Iowa Road Law

A road law that varies widely in its fundamental principles from the heretofore accepted forms of state-highway control was enacted by the legislature of the State of Iowa on April 9. The new law creates a state highway commission of three members, one of which is, ex officio, the dean of engineering of the Iowa State College at Ames, Iowa, and the other two members are appointees of the governor selected from different political parties for four-year terms. The headquarters of the commission are at the Iowa State College. Each of the commissioners appointed by the governor is allowed $10 per day for each day actually employed in the work of the commission, the total compensation not to exceed $1000 per annum.

The duties of the commission are to devise and furnish standard plans of highway construction and maintenance suited to the needs of the different counties of the state; to disseminate information and advise the county supervisors and officers on questions pertaining to highway improvement, construction and maintenance and as to reasonable prices for all materials of construction; to make investigations as to conditions in any county and report any violation of duty, either of commission or omission, to the attorney-general; to have general supervision of the various county and township officers in their relation to highway work; and to record and report annually to the governor all important operations of the commission. For this work the commission is authorized to select and employ such competent assistants as are necessary and to fix their salary and regulate their terms of employment.

County-Highway Engineer.

The law further requires that each county, through its board of supervisors, shall employ a competent engineer, whose tenure of office may be terminated by the highway commission for incompetence or maladministration of the office of county-highway engineer. The salary of the engineer is to be fixed by the county board of supervisors. The board of supervisors is required to designate which roads will form the county-highway system, its selection to be main-traveled roads aggregating not less than 10 per cent nor more than 15 per cent of the total mileage in the county. The roads so designated are to be known as the county-highway system, as distinguished from the township-road system. The county system will be shown on a standard scale map and examined by the highway commission in connection with the maps from adjoining counties, with reference to their continuity and probable cost of construction and volume of traffic. The commission will have final approval of the roads as selected by the board of supervisors; and in case any county shall fail to designate its county-road system the highway commission has the power to make such designation, the county bearing the burden of the expense.

Commission Has Final Approval

The county engineer is to survey and report, with accurate plans and profiles, the county-road system as finally approved by the highway commission. This report is required to show cut and fill quantities, cross-sections, surface and lateral drainage, size and location of all lines of tile, all bridges and culverts, and an estimate of the watershed of each bridge and culvert. The report, after being approved by the board of supervisors, must be submitted to the state highway commission. After the surveys and plans have been passed upon by the highway commission they are to be returned to the county engineer with full and explicit directions as to modifications. The board of supervisors is then to do the road, bridge, tile and culvert work in strict accordance with the approved plans and specifications. The cost is to be borne by the county from its road and bridge funds.

The new law does not provide for state aid. It requires a county-road tax of from 4 to 6 mills annually, an equitable distribution of 85 per cent of the automobile license fund, and a bridge tax of not more than 5 mills. Besides the sums available from these levies, there may be special township taxes and a 1 mill tax is required to be applied solely to dragging township roads. The township-road system is to be selected by the township trustees, who are to appoint a township-road supervisor. The duties of the latter will be to see that all roads in his system are properly dragged and repaired. Bridges and other costly improvements on township-road systems are to be built by the county under the direction of the county engineer.

Responsibility for Condition of Roads

The responsibility of the repair and dragging of the county-road system is vested in the board of supervisors and the county engineer, and does not come in the province of the highway commission. By repair work is interpreted work that is not designated by the highway engineer, work of a temporary character or of immediate necessity, and work necessary to maintain the finished roads completed under this law.

The county engineer is required to certify to all bills on work that is being done under the guidance of the state commission, and becomes liable on his bond for any inaccuracy or falsity in them. He is also obliged to report annually to the board of supervisors of the work accomplished on the roads for the current year in both the county and township systems.

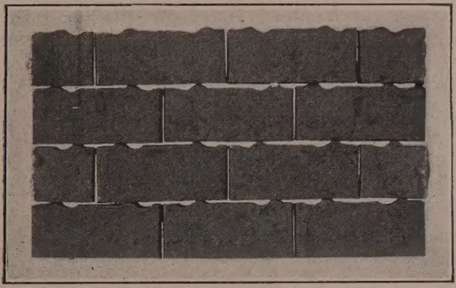
Wire-Cut Lug Paving Blocks

By F. B. Marsh, Assistant Designing Engineer, Board of Water Supply, New York City

The rapid increase in the use of motor vehicles in recent years, not only for pleasure but increasingly for general trucking and business purposes in city and country alike, makes a well-built brick pavement peculiarly attractive financially as well as in other particulars, for it is reasonable to assume that a modern brick pavement, relieved of much of the shock and grinding of iron-bound traffic, will materially outlast the brick pavements of 20 years ago, many of which are still in satisfactory condition, though practically nothing has been spent on them for repairs.

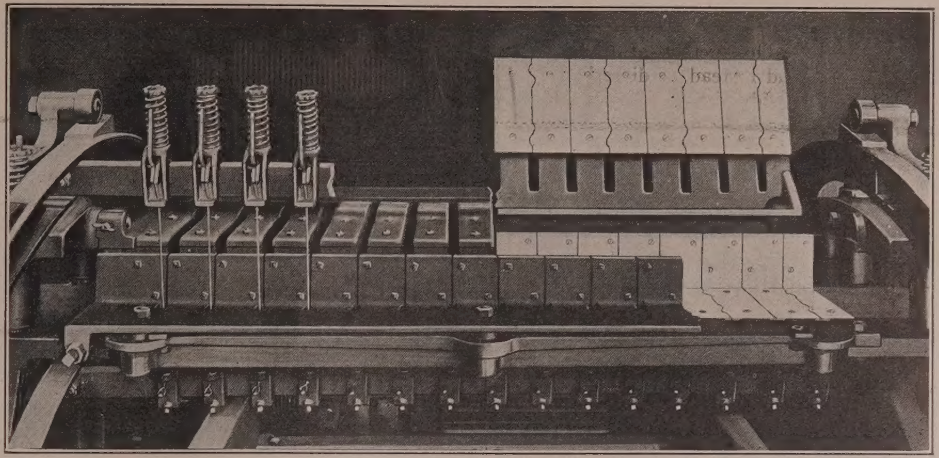
These earlier pavements were laid with bricks of the small or "brick" size as distinguished from the modern or "block" size, the quality of the raw material was often poor and the methods of burning crude; there was no standard method of testing, and the importance of apparently minor details in laying the pavement was not fully appreciated. One after another these conditions have been remedied. Still another forward step has now been taken in the perfection of a machine for turning out what are termed wire-cut lug blocks as distinguished from the repressed variety.

In making the repressed blocks the plastic clay or ground-up shale is forced under high pressure through a rectangular die, forming a thick ribbon of the material, which is then cut crossways by wires into blocks. These are then put into molds slightly larger than the block in section, and a powerful plunger is then brought down to do the repressing, as it is called. The purpose of this repressing is to form lugs and grooves in what will be the sides of the block, so that when laid in the pavement there will be space enough between adjacent blocks to admit the filler freely to the bottom of the joint and thus bond the blocks into a monolithic pavement. After repressing they are sent to the dryer and finally burned in the kiln. Repressed blocks are made with rounded or beveled edges because it is impracticable with the repressing process to form satisfactory square edges.



Pile of New Type Block to Show Uniformity of Spacing

In making the wire-cut lug block the necessity for the repressing is eliminated by so guiding the wires that cut the blocks from the ribbon of plastic clay that lugs of any desired dimensions are accurately formed without repressing, and the block itself is left with square and true edges.



Machine for Cutting Wire-Cut Lug Block

Parts of the platen are broken away to show the shape of the slots which guide the cutting wires. The column of clay, 9½ in. wide and 4½ in. high, passes through the platen to the left end when the cutter is automatically set in motion and the wire frame travels across and through the column, cutting it into fourteen blocks. The slots in the platen have offsets, which deflect the wires, thus forming lugs and grooves. The cutter is mounted on a carriage and travels with the column of clay, which is a continuously moving column, while the cut is being made. When the wires clear the column the carriage returns toward the auger for another cut. The top platen is raised while the cutter is returning.

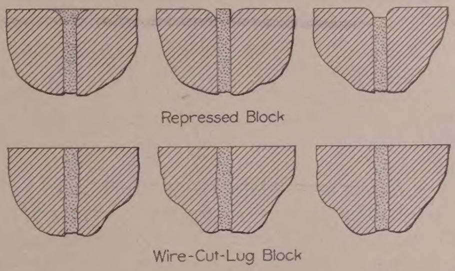
After some two or three years' experience with the wire-cut lug blocks there seems to be no question but that they are superior to repressed blocks made from the same raw material. While their manufacture requires the use of a patented machine, any reputable manufacturer can readily arrange to use it, and the royalty charged is about equal to the cost of the repressing process, so that large brickmakers who have installed the new process and still retain the other declare that as far as cost is concerned it is immaterial to them which type of block is turned out.

Advantages of Wire-Cut Lug Block and Results of Rattler Test

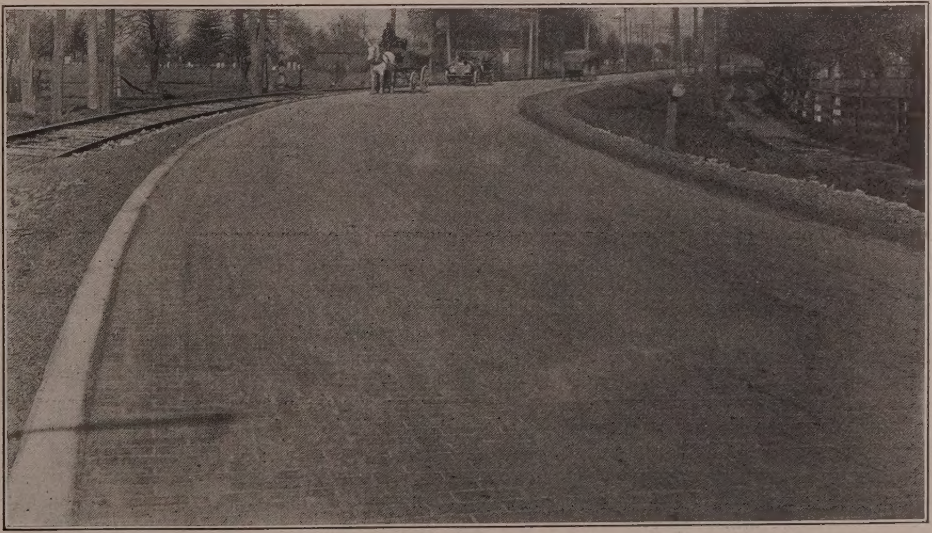
The principal advantages of the wire-cut lug block are: (1) The elimination of the repressing process apparently results in brick of better quality and texture; (2) the square edges make a smoother and better pavement than the round edges of the repressed block; (3) the rough, wire-cut side surfaces and the uniformity of the lugs give the best possible opportunity for the filler to make a strong, monolithic pavement.

The repressing of the ordinary paving block is claimed by the advocates of the new type to increase, if anything, its volume and therefore to decrease its density. This may not be strictly true in all cases, but it is evident that the re-forming of the somewhat plastic but yet stiff clay to dimensions all of which are materially different from those of the block as left by the cutter not only tends to produce the alleged result but may accentuate any incipient laminations or planes of weakness in the block. Examination of the fractures of blocks of the two types seems to indicate that this is at least occasionally true.

The principal test of quality, however, and the one on which acceptance or rejection generally depends, is the combined impact and abrasion of the standard rattler. Brick manufacturers who make both the repressed and the wire-cut lug blocks state that the latter passes the rattler test with no greater loss than the other. Its superiority is therefore evident, for if the two were of exactly the same quality, the sharp edges of the wire-cut block would cause it to show the greater loss. This fact deserves more attention from engineers than it has apparently had, for unless it be the definite intention to make the specifications more stringent as regards the rattler test—and except for particularly severe traffic conditions such a course is not only unnecessary but decidedly questionable—it is only logical to permit a slightly greater loss in the rattler for a



How Filler Acts under Traffic with Repressed and Wire-Cut Block



Highway near Buffalo Paved with Wire-Cut Lug Block square-edged block than for a round-edged one. To determine what this difference should be it is necessary to conduct a thorough series of tests on blocks of the two kinds, made from the same batch of clay, ground, manipulated, dried, burned and cooled under identical conditions, all to be under the supervision of a recognized impartial authority on paving brick. Such tests might well be made by the committee on specifications for brick of the American Society for Testing Materials in conjunction with the National Paving Brick Manufacturers' Association.

Wire-Cut Lug Brick in the Pavement

The square edges of the wire-cut lug block make a smoother pavement than the round edges of the repressed block because the filler can readily be poured flush with the top of the pavement and does not break away at the surface under traffic as it often does from the round edges of the other. This is of particular importance where there is considerable iron-shod traffic, because the slight transverse depressions caused by this process tend gradually to increase in depth and width. Of course, on steep grades it is desirable to use blocks that are slightly beveled on one edge, to give better foothold. Such blocks can be readily formed in the wire-cut lug machine.

The uniformity of the lugs of the wire-cut block assures not only a uniform space for the filler between adjacent blocks but makes it somewhat easier to lay them so as to get good alignment of the courses across the pavement. With the repressed blocks the lugs are occasionally poorly formed or damaged. Moreover, the smoother surface of the repressed block is not as satisfactory for the filler to adhere to as the rougher, wire-cut surface of the other, whether the filler be cement grout or asphalt.

Of course, if a satisfactory method could be devised for properly spacing the blocks in the pavement a plain wire-cut block without lugs, such as was used in many of the older brick pavements, would be as good as anything; but experience has shown the necessity for limiting this joint space closely, say between 3/16 and ⅜ in., so that there will be width enough to admit the filler freely for the full depth and yet not result in too thick a filler.

After the receipt of Mr. Marsh's article certain particulars as to the most recent modification of the wire-cut lug block were received by the Engineering Record from the Dunn Wire-Cut-Lug Brick Company, of Conneaut, Ohio. Whereas in the original type each brick had lugs on one side and corresponding depressions on the other, in the latest type each brick has one flat side, the lugs and the depressions being both on one side. The reason for this is readily seen in the accompanying illustration of the cutter.

The particular advantage of this type of block is that with one perfectly flat side it insures against the possibility of laying them irregularly as to the direction of the lugs. Obviously in order to insure proper spacing the blocks must be laid with the lugs in one direction. It was found difficult to get ordinary laborers to distinguish between the lug and the groove sides of the older type, but with both lugs and grooves on the one side no difficulty is found.

Bond Issues for Highway Improvement in Texas counties to the total amount of $3,790,000 have received the endorsement of the majority of the voters in twenty-two elections specially held for that purpose during the first five months of 1913.

Flood-Prevention Investigations in Ohio

Plans for Controlling About 100 Miles of the Miami River and Other Streams

Immediately after the severe floods in Ohio and Indiana last March studies as to the best methods of preventing damage by future floods were undertaken at a number of points. Among the comprehensive investigations under way are those at Dayton and Columbus, and information regarding the character of the work has been received from Mr. A. E. Morgan, of Memphis, Tenn., and Mr. John W. Alvord, of Chicago, who have charge respectively of the Dayton and the Columbus work.

Investigations at Dayton

The work at Dayton is being carried on by the flood-prevention commission of Montgomery County, acting in co-operation with the Board of Public Works of the city of Dayton and the county board of Montgomery County. Each of these boards has recently been enlarged in accordance with an act of the legislature to include four members. Those on the county board have been appointed by the probate judge. Certain members of the flood-prevention commission are members of these two boards.

A private subscription of somewhat more than $2,000,000 has been raised to assist in handling the flood-protection situation, and the cost of the survey will be paid out of this fund. The cost in the early stages was advanced by the National Cash Register Company.

The Morgan Engineering Company, consulting engineers, of Memphis, Tenn., as previously announced in the Engineering Record, has been put in charge of surveys and the preparation of plans for flood prevention. At the request of the company the members of the flood-prevention commission authorized it to choose a board of consulting engineers to advise with it in the preparation of these plans. The board is made up of the following members: Prof. D. W. Mead, University of Wisconsin, Madison; Prof. S. M. Woodward, Iowa State University, Iowa City, Iowa, and Mr. John W. Alvord, sanitary and hydraulic engineer, Chicago.

The general object of the investigations will be the preparation of plans for flood protection on the Miami River from the south line of Montgomery County, about 20 miles below Dayton, to the headwaters—a distance of about 100 miles, and incidentally to plan similar flood protection on Mad River, Stillwater River and Wolf Creek. The possibilities of a park system and city planning for the city of Dayton and other cities of the valley will be considered and at the same time the possibilities of protecting agricultural land from floods are to be determined.

Engineering Organization

A branch office of the company has been opened in Dayton. Mr. O. N. Floyd is in charge of the field work under the direction of Mr. Arthur E. Morgan and Mr. L. L. Hidinger, each of whom is spending part of the time in Dayton and part of the time in the field. The necessary hydraulic investigations are in charge of Mr. I. E. Houk, who is also at the head of Party 1.

Four special parties have been organized. Party 2 is located at Dayton, and will make surveys within the city and in the Miami Valley from Dayton south to the boundary line of Montgomery County. Party 3 is making surveys on Mad River and Wolf Creek. Party 4 is collecting data in the smaller towns and on the Stillwater River. Party 5 is working in the Miami Valley northward from the city limits of Dayton to the headwaters.

Details of Investigations

The first work of Party 1 is to make estimates of the total flow which occurred during the recent flood. These are being made by estimating the flow through bridge openings and through typical sections of the valley. Estimates of runoff will be made separately for the Miami, Mad, and Stillwater Rivers, Wolf Creek and the other principal tributaries of the Miami. Measurements on the last-named stream will be made above and below the junctions with its principal tributaries. When this work is completed hydraulic factors, such as the roughness factor of the river channels and the capacities of bridge openings, will be investigated.

Party 2 will prepare data for a topographical map of the city of Dayton, filling in the information which cannot be secured in the city engineer's office. This party, in co-operation with the office force, will prepare a map showing the value of real estate and improvements in all the flooded district of the city, which will be used in estimating the value of flood protection and the cost of condemnations for improvements. Together with a topographical survey, the elevations of the flood crest in all parts of the city and along the sides of the valley through the city will be determined.

Data which would indicate the velocity of the current through the city will be secured. The cost of replacement of bridges and other public structures will be determined.

The disposition of the Miami & Erie Canal right-of-way and structures is also a consideration. Possible routes for the diversion of the rivers away from the city will be very carefully surveyed and all factors affecting channel improvements will be investigated. This will include borings to determine the character of the earth along the route of possible improvements. The channel of Mad River will be cross-sectioned at frequent intervals and will be located definitely, if it seems necessary, in order to determine its present capacity and to furnish data for estimating the cost of improving the channel.

Wolf Creek and Piqua Surveys

Party 3 will secure data for a complete plan for the control of Wolf Creek, the reclamation of agricultural land adjacent, and the protection of roads and bridges on the stream. While this investigation will have little bearing on the general flood situation, it is being made at once, as some of the principal highways are interrupted and are being washed out by frequent freshets. The control of Wolf Creek comprises a great many details, as it is a very flashy stream and must be controlled almost throughout its course.

Most of the territory traversed by Mad River has been covered by the U. S. Geological Survey, and maps have been prepared with 20-ft. contour intervals. It seems necessary to make a resurvey of this valley to determine the progress of the flood crest with reference to both time and stage and a determination of the actual storage which existed in this valley during the flood. Moreover, the contour lines do not show the edge of the valley where these slopes are gentle, and it is necessary to locate the profile of the overflow. Cross-sections of the valley will be taken up to the flood height and on occasions to an elevation 50 ft. above the flood height to indicate the conditions which would exist if storage reservoirs were constructed.

Wherever there is apparently an advantageous situation for a reservoir dam more detailed surveys will be made. Important improvements which might be affected by reclamation plans or by construction of reservoirs will be located and described.

Party 4 will work in the neighborhood of Piqua. The city is about to install a water supply system, and it appears that the most feasible source of supply consists of wells sunk in the river bed. The city has been advised not to make definite plans for this work until a survey of the situation can be made in order to determine the best method of improving the Miami River through the city, so that any work done toward securing a water supply may, if possible, be adjusted to such plans. As the water supply of the city may be cut off at any time by a break in the temporary repairs of the banks of the canal through which the city receives its supply, this work was taken in hand at once. A general survey of the city will be made with the object of planning flood protection and to cover the same points that are covered in Dayton.

GENERAL

The same ground will be covered at Miamisburg and all of the other towns in the valley that were affected by the flood.

Party 5 is located in the Miami Valley, where the same data will be collected as in the Mad River Valley, particular consideration being given to the possibility of the reclamation of agricultural lands.

Investigations will be made as to the possibility of diverting these rivers around the city of Dayton or into other watersheds, of making cutoffs on the river through Dayton, and of constructing storage reservoirs. Several railroads have heavy investments in the Miami and Mad River Valleys, and their relations to a general plan for flood relief are being considered.

Up to the present time about half of the Miami Valley has been covered by the survey, but most of the work on the Mad and Stillwater Rivers and in the city of Dayton remains to be done. Probably three months will be required to complete the field work and an equal length of time in working out the principal features of the various plans which may be considered.

INVESTIGATIONS AT COLUMBUS

The work under way at Columbus may be classified under five general heads:

1. Valuation maps are being prepared which will enable the engineers to compute the cost of widening old channels or providing auxiliary channels, and from such data some estimate may be made of the probable average annual loss of recurring floods in the future. A comparison of the total value of the property in the flooded district with the cost of various methods of relief will give a proportionate idea of the relation between the protection and the invested capital.

2. Parties are in the field checking up and measuring high-water marks, obtaining cross-sections of the river valley above and below the cities, and obtaining various other cross-sections where surface-water slopes are well recorded, all for the purpose of determining the hydraulic elements of the recent flood, for use in computations as to its control and its total amount.

3. The available rainfall data are being studied and platted, the history of the past floods is being obtained as far as possible, and studies are being made on the periodicity of such floods and their magnitude on rivers of this character. These data will enable some conception to be formed of the greatest possible floods which are to be expected.

4. Parties are in the field making a complete survey of the present river channels and their vicinity and of the suggested auxiliary channels which may have to be provided. This work includes contour maps, borings, the location of all buildings, depth of bridge foundations, and other data necessary to know how to improve and enlarge the present channels or design additional channels.

5. Researches to determine the practicability of storage reservoirs on the upper watershed of the rivers in question have been undertaken. Such sites as seem feasible will be surveyed, their storage computed, and their effect upon the crest height of the floods ascertained. It is fortunate, Mr. Alvord points out, that at Columbus the entire flood flow of the Scioto passed over the storage dam, which will give a much closer estimate of the flow than would probably have been the case otherwise.

It is thought that a study of the flood cross-sections above and below the Columbus dam will yield some knowledge of the coefficients in the ordinary valley section of that and similar rivers derived from the known flow over the dam. Information of that kind should aid in determining the probable crest flow of the flood in other sections of the rivers, as well as in some of the more irregular auxiliary channels that may have to be designed in the near future.

USE OF DATA COLLECTED

When the data are all in it is expected that there will be laid out a number of tentative methods of reservoir flood control and channel improvement, both on the basis of enlarging the present main channels and by adding auxiliary channels. These projects will be placed on a comparative basis and presented to the public officials and the citizens generally for their study. It is intended and expected that the Board of U. S. Army Engineers will review and pass upon the recommendations as soon as completed.

The city of Columbus is planning to print a report containing a summary of the above studies. It is hoped to have the report out in due time so that a bond issue may be proposed and voted upon this fall.

THE HYDROELECTRIC PLANT which is being put in by the Andrew Terry Company, manufacturers of castings, Terryville, Conn., is of interest as showing the gradual development of small streams for the local use of power. In this case an old dam one-half mile below the present factory across the Pequabuck River has been used as the site for a new plant operating under 36-ft. head. The prime mover, designed for 130 hp, consists of a pair of 12-in. wheels built by the S. Morgan Smith Company, of York, Pa., and operating at 720 r. p. m. The wheel is direct-connected to a Westinghouse three-phase generator rated at a maximum of 135 kva and delivering current at 2400 volts. Water is carried from the dam to the wheels through a headrace canal delivering into a steel penstock 42 in. in diameter and 325 ft. long. The dam provides a considerable storage of water, and it is expected that when the entire project is complete there will be no demands upon the steam-power plant except for a few weeks in the extremely dry season.

Waterproofing of Concrete

Report (Slightly Condensed) of the Committee on Waterproofing Materials of the American Society for Testing Materials, Presented June 28

While it has not been able to arrive at sufficiently definite conclusions to enable it to formulate specifications for the making of concrete structures waterproof or for materials to be used in such work, the committee has reached certain conclusions which may be of assistance in securing impermeable concrete.

The work was found to subdivide naturally into three branches:

1. The determination of causes of the permeability of concrete, and the best methods of avoiding these causes.

2. The rendering of concrete more waterproof by adding other substances.

3. The treatment of exposed surfaces after the concrete or mortar has been put in place, either by penetrative, void-filling or repellent liquids, making the concrete itself less permeable; or by extraneous protective coatings, preventing water having access to the concrete.

These several subdivisions are considered separately.

CAUSES OF PERMEABILITY OF CONCRETE

In the laboratory and under test conditions using properly graded and sized coarse and fine aggregates, in mixtures ranging from 1 cement, 2 sand and 4 stone to 1 cement, 3 sand and 6 stone, impermeable concrete can invariably be produced. Even with sand of poor granulometric composition, with mixtures as rich as 1 cement, 2 sand and 4 stone, permeable concrete is seldom, if ever, found and is a rare occurrence with mixtures of 1 cement, 3 sand and 6 stone. But the fact remains, nevertheless, that the reverse often obtains in actual construction, permeable concretes being encountered even with 1 cement, 2 sand and 4 stone mixtures and are of frequent occurrence where the quantity of the aggregate is increased. This the committee attributes to:

(*a*) Defective workmanship, resulting from improper proportioning, lack of thorough mixing, separation of the coarse aggregate from the fine aggregate and cement in transporting and placing the mixed concrete, lack of density through insufficient tamping or spading, and improper bonding of work joints, etc.

(*b*) The use of imperfectly sized and graded aggregates.

(*c*) The use of excessive water, causing shrinkage cracks and formation of laitance seams.

(*d*) The lack of proper provision to take care of expansion and contraction, causing subsequent cracking.

Properly graded sands and coarse aggregates are rarely, if ever, found in nature in sufficient quantities to be available for large construction, and the effect of poorly graded aggregates in producing permeable concrete is aggravated by poor and inefficient field work. Even if we could afford the added expense of screening and remixing the aggregates so as to secure proper granulometric composition to give the density required to make untreated concretes impermeable, it is seemingly often a commercial impossibility on large construction to obtain workmanship even approximating that found in laboratory work.

ADDITION OF FOREIGN SUBSTANCES

The committee finds that in consequence of the conditions outlined above substances calculated to make the concrete more impermeable—either incorporated in the cement or added to the concrete during mixing—are often used.

While it has been impossible for the committee to test all of the special waterproofing compounds on the market, it has investigated a sufficient number of these, as well as the use of certain very finely divided mineral products, such as finely ground sand, colloidal clays, hydrated lime, etc., to form a general idea of the value of the different types. The committee finds:

(*a*) That the majority of patented and proprietary integral compounds tested have little or no immediate or permanent effect on the permeability of concrete and that some of these even have an injurious effect on the strength of mortar and concrete in which they are incorporated.

(*b*) That the permanent effect of such integral waterproofing additions, if dependent on the action of organic compounds, is very doubtful.

(*c*) That in view of their possible effect, not only upon the early strength, but also upon the durability of concrete after considerable periods, no integral waterproofing material should be used unless it has been subjected to long-time practical tests under proper observation to demonstrate its value, and unless its ingredients and the proportion in which they are present are known.

(*d*) That in general more desirable results are obtainable from inert compounds acting mechanically than from active chemical compounds whose efficiency depends on change of form through chemical action after addition to the concrete.

(*e*) That void-filling substances are more to be relied upon than those whose value depends on repellent action.

(*f*) That, assuming average quality as to size of aggregates and reasonably good workmanship in the mixing and placing of the concretes, the addition of from 10 to 20 per cent of very finely divided void-filling mineral substances may be expected to result in the production of concrete which under ordinary conditions of exposure will be found impermeable, provided the work joints are properly bonded and cracks do not develop on drying, or through change in volume due to atmospheric changes, or by settlement.

External Treatment

While external treatment of concrete would not be necessary if the concrete itself, either naturally or by the addition of waterproofing material, was impermeable, it has been found in practice that in large construction, no matter how carefully the concrete itself has been made, cracks are apt to develop, due to shrinkage in drying out, expansion and contraction under change of temperature and moisture content and through settlement.

It is, therefore, often advisable on important construction to anticipate and provide for the possible occurrence of such cracks by external treatment with protective coatings. Such coating must be sufficiently elastic and cohesive to prevent the cracks extending through the coating itself. The application of merely penetrative void-filling liquid washes will not prevent the passage of water due to cracking of the concrete. The committee has, therefore, divided surface treatment into two heads:

(*a*) Penetrative void-filling liquid washes.

(*b*) Protective coatings, including all surface applications intended to prevent water coming in contact with the concrete.

While some penetrative washes may be efficient in rendering concrete waterproof for limited periods, their efficiency may decrease with time and it may be necessary to repeat such treatment. The committee, therefore, believes that the first effort should be made to secure a concrete that is impermeable in itself and that penetrative, void-filling washes should only be resorted to as a corrective measure.

While protective extraneous bituminous or asphaltic coatings are unnecessary, so far as the major portion of the concrete surface is concerned, provided the concrete is impermeable, they are valuable as a protection where cracks develop in a structure. It is therefore recommended that combination of inert void-filling substances and extraneous waterproofing be adopted in especially difficult or important work.

Bituminous or Asphaltic Coatings

Considering the use of bituminous or asphaltic coatings, the committee finds:

(*a*) That such protective coatings are often subject to more or less deterioration with time, and may be attacked by injurious vapors or deleterious substances in solution in the water coming in contact with them.

(*b*) That the most effective method for applying such protection is either the setting of a course of impervious brick dipped in bituminous material into a solid bed of bituminous material or the application of a sufficient number of layers of satisfactory membranous material cemented together with hot bitumen.

(*c*) That their durability and efficiency are very largely dependent on the care with which they are applied.

Such care refers particularly to proper cleaning and preparation of the concrete to insure as dry a surface as possible before application of the protective covering, the lapping of all joints of the membranous layers, and their thorough coating with the protective material. The use of this method of protection is further desirable because proper bituminous coverings offer resistance to stray electrical currents, the possible attack from which is referred to later.

Richer Mixtures

So far the committee has considered only concretes of the usual proportions, namely, those ranging from 1 cement, 2 sand and 4 stone to 1 cement, 3 sand and 6 stone. It has been suggested that impermeable concretes could be assured by using mixtures considerably richer in cement. While such practice would probably result in an immediate impermeable concrete, it is believed by many that the advantage is only temporary, as richer concretes are more subject to check cracking and are less constant in volume under changes of conditions of temperature, moisture, etc. Therefore, the use of more cement in mass concrete would cause increased cracking, unless some means of controlling the expansion and contraction be discovered. With reinforced concretes the objection is not so great, as the tendency to cracking is more or less counteracted by the reinforcement.

It has also been suggested that the presence in the cement of a larger percentage of very fine flour might result in the production of a denser and more impermeable concrete, through the formation of a larger amount of colloidal gels.

Neither of these suggestions has been especially investigated by the committee. Both appeal to the committee, however, for the reason that they substitute active cementitious substances for the largely inactive void-filling materials previously recommended, thus increasing the strength of the concrete.

In conclusion, the committee points out that no addition of waterproofing compounds or substances can be relied upon to counteract completely the effect of bad workmanship, and that the production of impermeable concrete can only be hoped for where there is determined insistence at all times on good workmanship.

The production of impermeable concrete has assumed greater importance since its appointment, the committee states, owing to the well-known injurious action of saline or alkaline waters and to the suggested possible effect of the moisture in concrete occasioning or aggravating electrical action from stray currents.

Originally the question of waterproofing involved mainly the physical troubles resulting from water passing through concrete, without any special consideration of its effect on its durability, other than a gradual leaching out of the cement. Recent developments suggest the possibility that owing to the increased conductivity of damp concrete to electrical currents such currents, if present, may so affect damp concrete as to lessen its integrity seriously, and this possibility further emphasizes the importance of the recommendation that no waterproofing compound of unknown chemical composition be added to concrete, as recent tests seem to show that the action of electrical currents is aggravated by the presence of certain solutions.

Bending Cast-Iron Pipe

Through somebody's oversight no curves or sleeves were ordered for a line of cast-iron pipe which the United Fruit Company had decided to lay to convey water from the Guayabo River to the town of Preston, Cuba. The canyon through which the pipe passes for a distance of about 2 miles from the dam is crooked, making impossible such easy curves as could be made in the pipe joints. As it might have taken several months to secure additional specials the local engineer—not a waterworks man—decided to bend some of the straight cast-iron pipe. How this seemingly impossible feat was accomplished is described in a paper read before the New England Waterworks Association by Mr. Charles W. Sherman, of the firm of Metcalf & Eddy, of Boston.

The Cuban workers had frequently bent steel or wrought-iron pipes at their sugar mills and they followed the same course of procedure with the cast-iron pipe, with entire success, as they did not break or spoil a single pipe. The pipes were bent to various radii, the shortest being 50 ft.

A cradle of old rails was first constructed with the desired amount of curvature. About one foot at each end of the pipe was left outside the fire, to prevent collapse of the pipe, and a fire of hardwood was built under and around the remainder of the pipes. Six or eight pipes were bent at a time. In one and one-half to two hours after starting the fires the pipes were hot enough to bend and settled from their own weight to the cradle prepared to receive them.

These particular pipes were 10 in. in diameter, with 9/16-in. thickness of shell, corresponding to Class D of the New England Waterworks Association specifications, the weight of which is 760 lb. per 12-ft. length.

Forty-five Women were among the seventy-seven applicants for a recent examination for the position of inspector in the Bureau of Highways, Philadelphia.

Comparison of Column Formulæ

By E. L. Lasier, Bureau of Standards,
Washington, D. C.

A surprisingly large number of formulæ has been found to be used by engineers in column design. The comparative study of the collected formulæ is most interesting to engineers and for that reason is here presented.

Twenty-seven formulæ were studied, as shown by the curves in Figs. 1, 2 and 3. All of the formulæ are used for medium steel columns, or steel having an ultimate strength of approximately 60,000 lb. per square inch. All also apply to conditions of flat ends.

The following nomenclature has been adopted:

P/A = ultimate or permissible load in lb. per square inch.

L/R = ratio of length of column (between confined ends) in inches, to least radius of gyration, in inch units.

f_c = a constant (usually taken as the allowable fiber stress in compression).

c = a constant.

E = modulus of elasticity, assumed when necessary as 29,500,000 lb. per square inch.

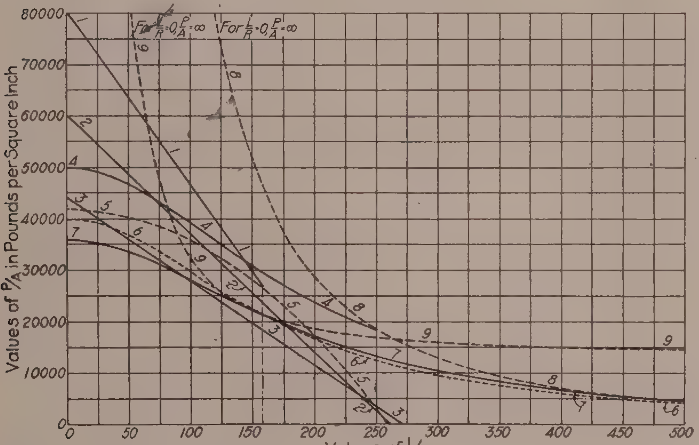


Fig. 1—Ultimate Strengths of Columns According to Formulæ 1 to 9

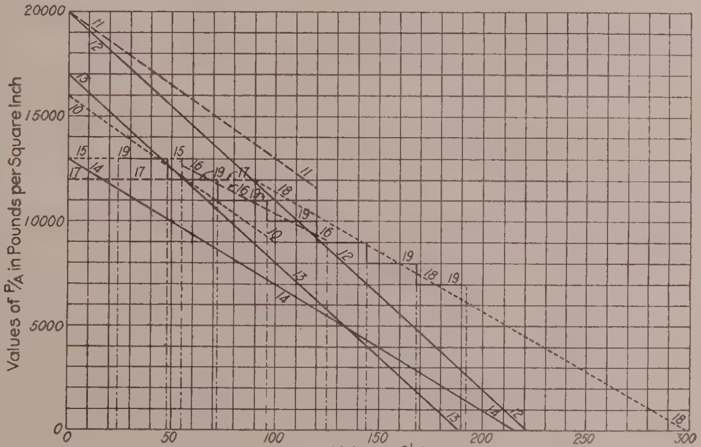


Fig. 2—Allowable Unit Loads of Columns According to Straight Line Formulæ 10 to 19

The curves in Fig. 1 are all curves for the ultimate strengths of the columns for varying values of slenderness. Nine curves are shown, Nos. 1 to 9 inclusive. In Figs. 2 and 3 the curves are all curves for the allowable load to be placed upon the columns, in pounds per square inch, for varying values of slenderness. Fig. 2 contains the graphical representations for ten straight-line formulæ, Nos. 10 to 19 inclusive, and Fig. 3 contains graphical representations for eight curved line formulæ, Nos. 20 to 27 inclusive.

In order to plot these curves the formula was first reduced to a form involving only P/A and L/R as variables. Different values of L/R from 0 to 500 in the case of Figs. 1 and 3 and values from 0 to 300 in the case of Fig. 2 were assumed, and corresponding values of P/A were computed in each case. Where the formula is not to be used except for limiting values of L/R the curve has only been drawn for those inclusive limiting values.

The formulæ have all been put in one of the following types:

Straight line formula:

$$P/A = f_c - c\,(L/R)$$

Gordon's or Rankine's formula:

$$\frac{P}{A} = \frac{f_c}{1 + \dfrac{1}{c}\left(\dfrac{L}{R}\right)^2}$$

Parabolic formula:

$$P/A = f_c - c\,(L/R)^2$$

Euler's theoretical formula:

$$P/A = 4\,\pi^2 E\,(R/L)^2$$

Fidler's theoretical formula:

$$\frac{P}{A} = F + M - \sqrt{\frac{(F+M)^2 - 2.5\,F\,M}{1.3}}$$

The above is explained later.

The constants used in the different curves, with the corresponding number of the curve, are as follows:

Figure 1

No. 1. T. H. Johnson's straight-line formula:

$f_c = 80\,000$ $c = 337$

No. 2. T. H. Johnson's straight-line formula; Passaic Steel Co.:

$f_c = 60\,000$ $c = 230$

No. 3. Tetmajer's straight-line formula. (Used extensively also by engineers in Germany; reported by the Königliches Materialprüfungsamt, Berlin.):

$f_c = 44\,000$ $c = 162$

No. 4. Gordon's formula; Cambria Steel Co.:

$f_c = 50\,000$ $c = 36\,000$

No. 5. J. B. Johnson's parabolic formula:

$f_c = 42\,000$ $c = 0.62$

No. 6. Rankine's formula; Greene's "Structural Mechanics":

$f_c = 40\,000$ $c = 28\,600$

No. 7. Rankine's formula. (Used extensively by engineers in England; reported by the engineering department of the National Physical Laboratory, Teddington, Middlesex, England.):

$f_c = 36\,000$ $c = 36\,000$

No. 8. Euler's formula; Lanza's "Applied Mechanics." (Used extensively also by engineers in Germany; reported by the Königliches Materialprüfungsamt, Berlin.):

Not used when L/R is less than 150.

No. 9. Prof. Fidler's formula. (Used extensively by engineers in England; reported by the engineering department of the National Physical Laboratory, Teddington, Middlesex, England.):

F = a term involving several constants, the "least swing radius" (radius of gyration), and the length, and reduces down to 797,900,000 R^2/L.

M = a constant, 60 000.

Figure 2

Nos. 10 to 18 inclusive all belong to the straight-line type; the constants given, therefore, are to be substituted in that formula.

Nos. 10 and 11. American Railway and Maintenance of Way Association, "General Specifications for Steel Railway Bridges," 1906; also used by American Bridge Co., 1906, and Baltimore and Ohio Railroad, 1904:

No. 10. $f_c = 16\,000$ $c = 70$
No. 11. $f_c = 20\,000$ $c = 70$

Nos. 12, 13 and 14. Theodore Cooper's Specifications, 1906:

No. 12. $f_c = 20\,000$ $c = 90$ (chord segments, stiffeners)
No. 13. $f_c = 17\,000$ $c = 90$ (posts)
No. 14. $f_c = 13\,000$ $c = 60$ (lateral struts)

Nos. 15 and 16. Bethlehem Steel Co.:

No. 15. $f_c = 13\,000$ $c = 0$
No. 16. $f_c = 16\,000$ $c = 55$

Nos. 17 and 18. Carnegie Steel Co.:

No. 17. $f_c = 12\,000$ $c = 0$
No. 18. $f_c = 17\,100$ $c = 57$

No. 19. J. R. Worcester's modification of T. H. Johnson's straight-line formula. Worcester proposed a "step down" form, with a constant value of f_c for a given range of L/R, but decreasing the value of f_c by steps of 1000 for each increment of 24 in L/R. Worcester's formula is not used when the value of L/R is greater than 192.

Figure 3

Nos. 20 and 21. Gordon's formula: Massachusetts Railroad Commission's specifications for bridges carrying electric railways:

No. 20. $f_c = 16\,000$ $c = 20\,000$ (main members)
No. 21. $f_c = 20\,000$ $c = 20\,000$ (secondary members)

Nos. 22-27 inclusive all belong to the Rankine type; the constants given therefore are to be substituted in that formula:

$c = 36\,000$

Nos. 22, 23, 24. Osborne Engineering Co., 1903-1904.

No. 22. $f_c = 22\,000$ (highway bridges)
No. 23. $f_c = 19\,000$ (electric railroad bridges)
No. 24. $f_c = 17\,000$ (steam railroad bridges)

No. 25. New York Bridge Department.

$f_c = 20\,000$ $c = 8\,000$

No. 26. Pennsylvania Railroad, 1907.

$f_c = 16\,000$ $c = 13\,500$

No. 27. Philadelphia and Reading Railroad, 1906.

$f_c = 15\,000$ $c = 13\,500$

The main conclusion, if it may be so called, to be drawn from a study of the curves is a realization of the wide range of values obtainable when different formulæ are used for the same conditions.

It has been stated that, whenever known, the curve has only been drawn for a limited range of *L/R*. In several instances it has not been possible to discover that the author of a formula intended to restrict the range of *L/R*. In several such curves, it is to be noted, the value of *P/A* would become negative with a further increase in *L/R*.

The following also is observed: The formulæ are of several types. Nearly all embrace empirical constants. These constants in the case of the formulæ graphically represented in Figs. 2 and 3 involve the factor of safety. From the wide range of values obtainable either or both of two inferences is made. A low or high factor of safety may have been assumed, or empirical constants have been selected differing according to the experience or wisdom of the author of the formula.

There would appear, therefore, to be an urgent need for an extensive series of authoritative tests upon steel columns, the experimental determinations of breaking load to be compared with the results obtained by applying the several formulæ in use by engineers, and the adoption from the comparison of a more standard column formula.

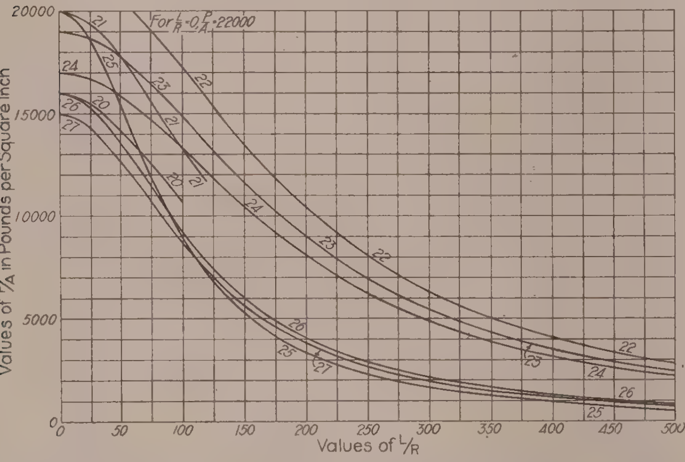


Fig. 3—Allowable Unit Loads According to Curved-Line Formulæ 20 to 27

The Advantages of Floating Drydocks were recently pointed out by Mr. James Fowler of Seattle, who stated in a report to the Vancouver harbor improvements committee that a floating dock would be better suited to Vancouver harbor than a graving dock, and would fill the needs of the port for many years to come. Floating docks can be built in about one-quarter the time and at a fraction of the cost, are quicker to operate and have the advantage of being movable in case shipping centers change, Mr. Fowler said, but he mentioned the necessity of having a location free from strong currents. Although more expensive to operate than the graving dock, the advantages of the floating type, Mr. Fowler thought, would more than offset that, and he pointed out that in Liverpool there was not a graving dock forty years old, as most of them had been superseded by newer types or demolished when shipping districts changed. Floating docks could be increased in length by placing more pontoons under them, Mr. Fowler stated, and the Seattle dock was cited as an instance where this feature of drydock construction was in contemplation.

Rates and Rate-Making under Wisconsin Public-Utility Law

Abstract of Paper by Halford Erickson, of the Wisconsin Railroad Commission, Delivered before the American Waterworks Association, Minneapolis, June 23-28

Governmental regulation of public utilities, while it operates as a restraint upon the actions of individuals and corporations, is not intended to interfere unduly with the management and operation of the industries affected. It is based upon the principle that public interests are superior to private interests. Public utilities especially are so affected by public interest that public policy requires that they should furnish adequate service at reasonable rates without unjust discrimination. This constitutes the main principle upon which regulation is based. No part of the regulation of public utilities is of greater importance than that which is concerned with the rates charged for the services they render. These rates measure the income of the utilities as well as the sacrifices which their customers must make in order to be served.

The public utility law of Wisconsin provides that the rates must be reasonable, both absolutely and relatively. The courts and the commission generally hold that, under normal conditions, the rates, when taken as a whole, should be high enough to yield reasonable amounts for operating expenses, including depreciation and interest and profit on the fair value of the property that is used and useful in serving the public. They also hold that each department of the service and each class of customers in each of these departments should bear their just proportion of these outlays. In other words, the cost of the service as thus stated is made the legal basis for rates.

Public interest requires that the rates should be high enough to cover the cost of adequate service and to bring the necessary capital and the best managing ability into the public utility field. The services of public utilities bear a close relation to the welfare and comforts of the community. Waterworks, for instance, are vitally connected with the health and with sanitary conditions.

Fire and Domestic Service

Practically every water-supply plant has two almost entirely distinct functions—the supply of large quantities of water, usually under high pressure, for relatively short periods of time for protection against fire, and the supply of water under moderate pressure at all times for commercial and industrial purposes. The fact that in many cases the furnishing of water for fire protection is the most important of the two general purposes for which water-supply systems exist seems to have been very generally overlooked by many of those who formulated the rate schedules which have been in use. In most places the charges to the municipality are fixed at so much per hydrant regardless of the cost to the utility of this service and of the distance between these hydrants.

Charges under flat-rate schedules in Wisconsin relate, first, to the character of the premises supplied; second, to the number of fixtures from which water is drawn; and, third, to other elements, such as the number of rooms or persons supplied. Even without the injection of special rates, flat-rate schedules are inevitably discriminatory.

When the flat-rate system fails, as it usually does in the long run, it is generally succeeded by the meter system of charging. Instances are known where the decreased waste that has resulted from the installation of meters and meter rates has been great enough to enable an overtaxed waterworks plant to furnish adequate service or the needed pressure. The meter rates thus put in effect, however, are not always the result of careful or scientific study. There are to-day many cities whose regressive schedules of meter rates are almost identical, although the cost of the service is greater in some of these places than in others.

Meter Schedules

The commonest type of meter schedules in use provides a decreasing charge per unit for increasing quantities of water used. Sometimes these rates are supplemented by a minimum charge, which in some cases varies with the size of the meter and in other cases not. Many of these schedules are mostly so adjusted that at some point they result in a higher total cost for a smaller than for a larger quantity of water. Rate schedules of this sort are, as a rule, unjustly discriminatory and unreasonable in other respects. The best methods of correcting such inequalities would seem to be by providing rates that bear closer relations to costs.

Because of the fact that water plants serve two widely different purposes, which makes the investment somewhat higher than it would be for either service separately, it becomes necessary to apportion the property so that each branch can be assessed with its fair share of interest, profits, and depreciation. There is no unanimity of opinion as to what the basis for apportionment should be. Generally speaking, however, it seems to be true that both classes of service should be considered as co-ordinate and that the apportionment should be made in such a way that this condition will be recognized. Instead of charging one class of service merely with the excess investment, the fairer method seems to be to consider that both classes of service need a public water-supply system and that each should bear the burden of interest, depreciation, and profits, according to an apportionment of the existing plant based upon the relative costs of entirely separate systems. This, in general, is the method which the Wisconsin Commission follows. It discloses the fact that fire protection alone is often responsible for from 40 to 60 per cent of the cost of the plant, depending on the size of the plant and other local conditions.

Apportionment of Expenses

It is evident that not all of the expenses of a water-supply system are affected by the amount of water pumped. The expenses incident to keeping the distribution system in repair are related only very indirectly to the number of gallons of water passing through the system. They depend rather upon the extent and capacity of the distribution system. The cost of reading meters and keeping the consumers' ledgers are related more directly to the number of consumers than to the amount of water they use. Not even all of the costs of pumping water are directly proportional to the volume of water pumped.

Three Elements of Expense

The operating expenses of a water utility may be said to be influenced by three principal elements—the demand which the plant must meet, the amount of water pumped and the number of consumers supplied. The first step in separating the cost of fire protection from the cost of general service must be to divide the operating expenses among the various classes of capacity, output, and consumer expenses, according to the elements which influence each expense item. It will be at once apparent that no arbitrary rule for apportioning expenses can be laid down which will cover all cases. For an average or typical plant the capacity expenses would amount to about 38 per cent, the consumer expense to about 18 per cent, and the output expense to about 44 per cent of the total operating expenses.

The output expense should be apportioned upon the basis of the amount of water pumped for the different branches of service. Capacity or demand expenses should be apportioned upon the basis of the respective demands of the two classes of service, with the exception, perhaps, of such items as the cost of maintaining mains, where the expense may be apportioned on the same basis as is used to apportion the investment in the distribution system. Consumer expenses should be allotted on the basis of the number of consumers unless treated as capacity costs.

Fire Service Rates

To formulate rate schedules for the fire service is, as a rule, a simpler task than is the case for the general service. When the municipality bears the entire cost there is in fact only one customer to deal with, and this cost can, therefore, be assessed in one lump sum instead of through a complicated schedule in which the demand and output costs are provided for by separate charges. When the municipality bears only that part of the cost of the fire service which is not covered by the cost for private hydrants, standpipes and sprinkler systems, and when the cost for the latter are borne by those who use them, the situation is more complicated. For in such cases, in addition to providing a rate for the municipality, it may be necessary to also provide detailed schedules for each of the private systems.

The demand upon the pumping station is determined by the fire risks in the district protected and may be expressed in terms of the number of fire streams of certain diameter and pressure necessary to make the protection adequate. Doubling the number of hydrants does not double the number of fire streams needed and the demand upon the station remains unchanged. Therefore there would be no necessity of additional investment in pumping-station or distribution system, except the cost of the additional hydrants. The fire-protection demand, which determines the investment required for protection purposes, is made by the district to be supplied, and consequently the interest, taxes and capacity expenses are dependent upon it and not upon the number of fixtures through which it must be exercised.

It is generally recognized that it is the duty of a city to furnish reasonably adequate fire protection. The utility must furnish enough water under sufficiently strong pressure to enable the city to supply adequate fire protection. Thus the fact that the city undertakes to furnish fire protection creates a demand which the utility must meet by incurring operating expenses and investment charges. The chief factor in determining the cost of a fire-protection system is the demand which the utility must be in a position to meet. Does the installation of private sprinkler systems increase this cost? The city may be able to take from its hydrants sufficient water to meet the fire demand, but because of the location of the hydrants and the character of the protection needed the water may not answer the purpose in all cases It is conceivable that the effect of private systems of this kind is to check fires and to decrease the probability that the maximum fire demand will be exacted.

On the other hand, there may be places where conditions are such that the private fire service tends to increase the investment or investment charges and possibly also certain items in the operating expenses. While the logic of the situation seems to be that the city, or the municipality, should bear the entire cost of the fire service, both public and private, there are many places where the municipalities have refused to assume this burden.

Consumer Costs

The capacity cost should be borne by each customer in proportion to his demand upon the plant or the investment therein. This demand is, in a way, measured by the size of the meter or service. A consumer having a 4-in. service pipe, even though he may use no more water than a consumer with a ¾-in. service, is in a position to demand and normally will demand more of the capacity of the plant. This element is recognized in electric rates rather generally. Inasmuch as the capacity and the consumer expenses are in the nature of fixed charges which continue even if individual consumers use practically no water, the rate schedule should provide a fixed charge varying with the size of consumer's service or meter, and independent of the use of water. This is what is known as the service charge.

With the capacity and the consumer costs more or less fully provided for in a service charge it remains to provide a charge that will cover the output cost. This can then be done by simply instituting a meter charge for a given quantity of water that is about equal to the average cost per unit obtained when the total output cost is distributed over the total amount of water sold. But conditions are not always normal. In some cases owing to defective demand data, local conditions and other causes, it is impracticable to cover the entire capacity and consumer costs in the service charge alone. When this is the case the costs which the service charge fails to cover must be added to the output or meter charges. Such conditions when met with must, of course, be recognized in fixing the meter charges. They often make it necessary to institute meter charges that are gradually growing lower as the consumption or use of water increases.

The facts thus presented suggest a rate schedule for the general service which is made up of a service charge covering the capacity and the consumer expenses, or as much of these items as is practicable, and of a meter charge of so much per 1000 gal. of water used. Owing to local and other conditions there are instances when it is both advisable and necessary to keep the demand or service charge down to a comparatively low level. For similar reasons it may also be advisable to adopt meter charges which decrease in amount with each successive step of increases in the quantity of water used.

There is also another kind of rate schedules in use in which the principles of the service or demand charge are to some extent, at least, provided for. These schedules are made up of a minimum charge graded according to the size of the meters or services, and which allow a certain quantity of water to be used under these minimums, which quantity is the same for all sizes of meters. In addition to this these schedules also contain meter charges for all water used in excess of the minimum, which meter charges are the same for large as for small meters, and often so adjusted as to decrease with each successive increase in the amount of water used. Such schedules when carefully developed are often fair to all concerned.

The cost method of rate-making as outlined usually leads to rates that will not only yield the requisite amount of revenues but that require each branch of the service and each customer therein to contribute their just share of these revenues. They provide like rates for like services under like conditions without unjust discriminations.

Cost Data on Motor Trucks Used to Haul a Contractor's Supplies

In building the Hemlock reservoir for the water system of Bridgeport, Conn., the Bridgeport Hydraulic Company, contractor for the work, has been using two 5-ton Locomobile motor trucks for hauling the materials. The distance from Bridgeport is 7 miles, and the roads are poor, with heavy grades.

From April, 1912, until about the end of the year, when the trucks were returned to the factory to be specially fitted up to handle 48-in. cast-iron pipe, they were used to haul cement and other material, records being kept of their performances. The trucks made from sixty-six to one hundred and fourteen trips per working month, covering from 920 to 1667 miles. The fixed charges for each truck were $15 per month for the garage, from $75 to $101 for the driver (bonuses being given for extra trips), $9.92 for interest, $8.12 for insurance and $88 for depreciation. This last item was figured at 25 per cent per annum on an investment of $4,764 less $540 for tires, the contractor expecting to use them two years only and then sell them at half their cost. Variable expenses ranged from $43 to $304 per month per truck.

Costs per ton-mile were computed from the monthly figures. They range from $0.073 to $0.134 for different months; for the entire period of operation of approximately nine months the final average for one truck was $0.091 and for the other it amounted to $0.106 per ton-mile.

A Railroad Costing but $5,353 per Mile, exclusive of rolling stock, is to be built in northwestern India, according to a U. S. consular report. It is not intended to spend more than about $2,800 per mile for rolling stock at first, making the total cost about $8,200 per mile. The line will be 77 miles long, over flat country, with no expensive bridge work. It will be only a light, feeder railway, of 2½-ft. gage.

Water-Supply System in the Fifty-Five-Story Woolworth Building, New York

Pump, Filter and Tank Service and Distribution and Pressure Control Supplies for Mechanical and Sanitary Purposes and Fire Protection

The $12,000,000 Woolworth office building in New York is about 850 ft. high above the lowest floor and has fifty-five stories above the street and three stories below it. It has a 150 x 200-ft. U-shape plan, with two 60 x 95-ft. wings of steel-cage construction, as described in several articles in the Engineering Record. The building requires an elaborate and costly water supply, larger and far more complicated and expensive than that for many small cities.

Supply and Classification

The water supply is derived entirely from several connections to the city mains at an average pressure of about 22 lb. and from a 24-in. main in Broadway which is normally connected only to the fire pump. All of the water is metered, filtered, and except that which is used below the second story is pumped into storage tanks located at different elevations. Each tank affords a gravity supply for a number of stories below it, within the limits of moderate working pressures, so that the fixtures and general service are subjected to no high pressures, the latter only being developed in the pump connections to the upper tanks.

Entirely separate systems are maintained for the mechanical plant, for fire protection, for toilet rooms, for offices and washrooms, for hot-water supply and for a public swimming pool and restaurant, all of which are more or less cross-connected so that they may be interchangeable in emergency.

The water supply provides for a large mechanical installation, for fire purposes, steam plant, large restaurants, swimming pool and for toilets and sanitary purposes for a tenancy of 7500 or 8000 people. No data whatever that were directly comparable with the conditions were available for the computation of the necessary water supply, and three independent estimates were made and compared: First, by comparison of the meter records of a number of very large New York office buildings, apartment houses and hotels; second, by the proportion of metered water to the square foot of rentable floor surface in different buildings; third, by the number of fixtures in the building, considered with regard to degree of flow of each fixture and the estimated number of times each of them would be used per hour.

Pump Requirements

The amount required for the operation of the entire mechanical plant and that necessary to supply all fixtures up to the second floor, which are under city pressure, were computed and their sum, equal to about 30 per cent of the total amount, was subtracted from the latter and the remainder was taken as the required capacity of the pumping plant. The total amount was divided into several portions, corresponding to the requirements of different sections of the building, and the pumping capacity for each of them was proportioned to the heaviest demand per hour, which, assuming that all pumps were worked continually at their maximum capacity for twenty-four hours, would give a capacity about six times that of the estimated daily supply, which is not very much in excess of the greatest hourly rate of supply.

In order to economize on the heavy cost of the metered water provision was made for saving and reusing the water used for washing the filters, which is found to be a large item of the supply, and the water used for condensation and cooling purposes and similar wastes. These waters, filtered once and stored in separate tanks, are augmented by a supplementary supply from the city mains and afford a separate independent service for the flush tanks in the toilet rooms. This supply is handled by independent pumps serving the same sections of the building and groups of fixtures as are served by another set of clear-water pumps, thus giving substantially duplicate units that provide a relay in case of accident or replacement, and did not involve any material difference in cost over a single set of larger pumps proportioned to do the same total duty.

The pumps are cross-connected to one another and to the fire pump. The flush-pumps and clear-water pumps have a combined capacity of 54,000 gal. per hour and the separate fire service has a capacity of 30,000 gal. per hour to a height of 820 ft. These, combined, would have, if continuously worked for twenty-four hours, a joint capacity six times as large as the assumed supply for the building. This excess, if reduced by the capacity of the fire pump, is not unduly greater per hour than the maximum demand. Each pump is automatically controlled by a pressure regulator placed on a valved by-pass.

Tank Regulation of Pressure

Inlets from three separate city mains are connected to an 8-in. header in the sub-basement, thence passing to single and double filters which supply a 10,000 gal. clear-water and a 20,000-gal. flush-water tank in the basement, from which suction pipes deliver respectively to the clear-water and flush-water pumps. All water for flushing purposes and the mechanical plant is filtered through single-cylinder sand filters. All other water is filtered through double-cylinder sand and bone-charcoal filters; thence all of it which is required for use above the first floor level is pumped to storage tanks at the twenty-seventh, fiftieth and fifty-third floors. The fiftieth floor tanks supply tanks on the thirty-eighth floor and the twenty-seventh floor tanks supply tanks on the fourteenth floor. Each tank supplies the floors between it and the next lower tank, and the corresponding supply sections are numbered downward 1, 2, 3, 4 and 5. By their use the pressure of the water in the distribution pipes and fixtures is reduced to a maximum of about 70 lb. All tanks are either divided or arranged in duplicate, permitting cleaning and painting without cutting off the service.

Fire-Protection System

The 20 x 9 x 18-in. Worthington horizontal duplex plunger pump is controlled by a pump pressure governor placed in a valved by-pass. It is direct-connected to the 24-in. Broadway main and cross-connected to an 8-in. pressure header, fed from separate 12-in. city mains in Broadway, Barclay Street and Park Place. It is connected with six lines of extra-strong galvanized wrought-iron standpipes with galvanized malleable-iron fittings, factory tested to 2000 lb. pressure and made up with red lead joints tested to 400 lb. hydraulic pressure after installation.

The standpipes are connected at five different upper levels with the open duplex storage tanks in the house system, which have a combined capacity of nearly 60,000 gal., which, together with the 30,000-gal. suction tanks and the 30,000-gal. swimming pool, are available for emergency fire supply. The tank connections to the standpipes are provided with horizontal swinging check valves, arranged so that each tank maintains its own pressure on all of the standpipes below it down to a level of one story below the next lower tank and is closed against standpipe pressure from the fire pumps or from fire engines in the street delivering through siamese fire-department connections on each of the three street fronts. The connections between the storage tanks and the standpipes cannot be cut off without shutting off the entire water supply for all the toilets in at least the twelve stories governed by these tanks.

The fire system has four 6-in. risers to the twenty-ninth story, one to the forty-first story, and one to the fiftieth story. Each has a 2½-in. hose connection at every story. Four of the risers extend through the roof of the twenty-ninth story and are provided with valved siamese hose connections. Each connection in the building has 75 ft. of linen fire hose. The standpipes were tested in place to 400 lb. pressure.

Street-Supply and Suction Tanks

The branches from the city mains are controlled at the curb by a valve in an accessible box and then pass through the thick concrete sub-basement wall in cast-iron sleeves provided with sheet lead flashing set in the concrete. Inside the walls the pipes are valved and provided with fish traps and water meters, beyond which they are connected to a header supplying the filters under a city pressure of about 22 lb. Water for clear-water service, after being filtered and refiltered, is stored in a 9 x 15 x 10-ft. 9-in. closed steel suction tank, accessible through two scuttles. The tank is filled through six ballcocks and delivers through an 8-in. suction pipe to the clear-water pumps installed near the center of the sub-basement.

Condensation water and other used water for flushing purposes are delivered through six ballcocks to the 20,000-gal, 9 x 30 x 10-ft. 10-in. flush-water tank in the sub-basement, which is also supplied from city pressure, and discharges through a 10-in. pipe connected in the pump room to the suction of the two flush-water pumps.

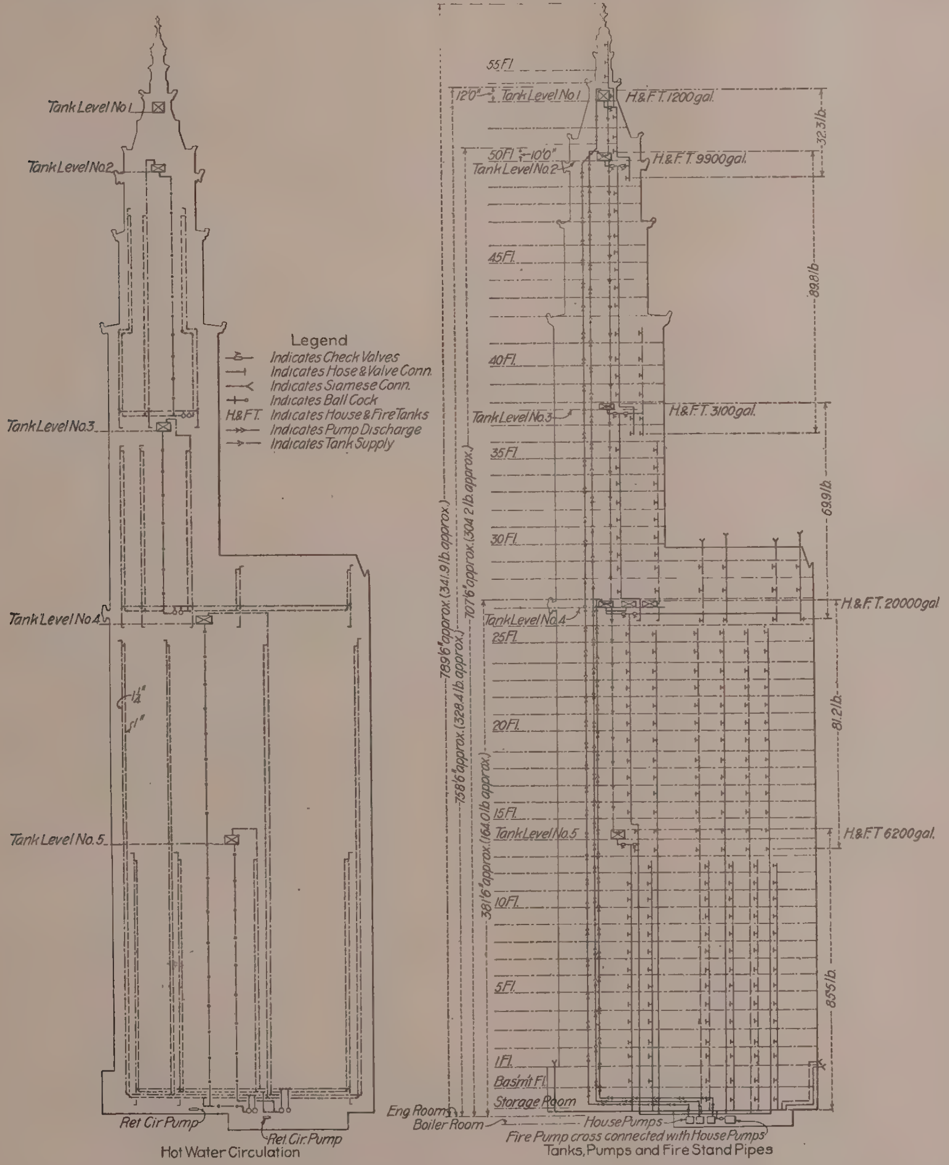
Pump Capacities

There are in the pump room three clear-water pumps, two flush-water pumps, and one fire pump devoted entirely to the house supply. All pumps are duplex Worthington pumps with the following capacities per minute against the heads indicated: For tank No. 1, 80 gal., 730 ft.; No. 2, 150 gal., 730 ft.; No. 4, clear water, 150 gal., 400 ft.; No. 4, flush water, 500 gal., 400 ft.; fire pump, 500 gal., 820 ft., with 5-in. suction and 6-in. discharge cross-valved to serve as relay for supply-tank pumps; two 50-gal. circulation pumps for hot-water heaters under pressure from tanks 4 and 5; one electrically operated automatic Deane single-acting triplex pump to deliver 20 gal. per minute 790 ft. high to tank No. 1. No. 3 tank is fed directly from the No. 2 tank and the No. 5 tank is fed from the No. 4 tank.

Each flush-water and clear-water supply

tank has a 2-in. supply pipe from the tank above, delivering to ball cocks set below the level to which the pump float valve falls, thus giving emergency feed if pump feed should become inadequate.

The arrangement of the storage tanks and distribution pipes and hot-water heaters in the different pipe galleries varies according to the space available, but generally resembles that just below the twenty-seventh floor. Here the 13 x 16-ft. 6-in. x 4-ft. 7-in. clear-water tanks and the 13 x 27-ft. 6-in. x 4-ft. 7-in. flush-water tanks are located over the twenty-sixth floor toilet rooms at the rear of the main part of the building adjacent to the light court.



Hot Water Circulation

Tanks, Pumps and Fire Stand Pipes

Conventional Diagrams of Arrangements of Pumps, Tanks and Riser Lines

The discharge pipes from the tanks are run in two groups to the front of the building and there connect with distributing lines run across the building near the center line of the front part and then to the rear in the lines of the corridors through the two wings. These lines pass close to the interior columns, where they connect with risers in wall chases.

Distribution Riser Lines

Except for tank No. 1, which only supplies a few fixtures in the upper part of the tower, all of the tanks are located in pipe galleries—that is, in short stories between regular stories, that are not tenanted and are reserved for this purpose and for storage and other uses. Here the distribution mains are carried into different parts of the building and riser lines are branched from them in wall chases of the usual description. For the lower part of the building, up to the twelfth story, the distribution is made on the ceilings of the basement and sub-basement. From the basement distribution there are twenty-seven groups of risers, all of them containing one hot and one cold clear-water pipe, and some of them an additional flush-water pipe.

All of the hot-water pipes are provided with expansion loops at every sixth floor, and the soil and waste pipes have special expansion fittings every twelve stories. Above the second story the heights of the stories average about 13 ft. All of the pipes are of extra-strong galvanized wrought iron except the hot water pipes, which are of brass and concealed in wall chases. The upper ends of all cold-water and fire standpipes are extended at least 8 ft. above the highest fixture and are closed to form air chambers. Vertical pipes of every kind have expansion loops every six stories. All pipes embedded in cinder concrete are protected by felt coverings.

Street Pressure and Heaters

The basement distributing main under 22 lb. street pressure serves all hot and cold water fixtures below the second floor with double-filtered water; single-filtered water is supplied to flushing systems, cooling coils, jackets of refrigerating machinery, boiler blow-off tanks, air compressor plant and to boiler feed.

All hot-water lines above sub-basement and all accessible hot and cold water risers are of brass pipe.

All hot-water heaters are designed to operate on exhaust steam and to heat the water from 45 to 170 deg. Fahr. The two heaters No. 2 each have a capacity of 500 gal. per hour; the two No. 3 heaters, each 750 gal.; two No. 4, each 1500 gal.; two No. 5, each 1000 gal., and two at street pressure, each 500 gal. The filters are connected in pairs. A set is provided for all the plumbing fixtures below the second floor that has a capacity of 100 gal. per minute; a second set of filters with a capacity of 200 gal. per minute is provided for boiler feed, for the cooling coils and for the mechanical plant.

Each vertical section of the building has a separate hot-water heater located near its cold-water tanks which distributes to the different riser lines through a horizontal pipe in the pipe gallery instead of one at the top of the section, as is arranged for the cold-water pipe. The hot-water risers of each section are connected at the upper ends to a single-return circulation pipe.

Restaurant and Swimming-Pool Systems

The systems for the restaurant service and for the 30,000-gal. swimming pool in the basement are planned to be available for operation by separate concessions and therefore have entirely independent metered water supplies, with their own filter systems and hot-water systems. The swimming pool has a system for the circulation of the water by pumps through filters and heaters so as to maintain the water at the desired temperature.

In accordance with the wishes of the fire underwriters, the suction from the fire pumps is connected to the outlet of the swimming pool, so that in case of necessity the contents of the pool may be available for fire purposes. The rain water from the roof is discharged through leaders and separate connections to the street sewer, and all sewer drainage below the ground floor is elevated to the street sewer through three Shone ejectors.

The principal water-supply equipment used includes eight Loomis-Manning standard filters, seven Worthington steam pumps or Deane electrical pumps, eight electric tank alarms, four 4-in. inlets from 12-in. mains in Park Place, Broadway and Barclay Street, one 5-in. direct intake from a separate 24-in. main in Broadway with 6-in. connections to the fire pump, 8-in. header and boiler room.

The original plans provided for 900 office wash basins, with a possible addition of 1388 more, 448 closets, 2 showers, 134 urinals, 135 toilet rooms, 69 lockers and 90 drinking fountains, afterward omitted.

The engineering features of the water supply and sanitary system were designed and the installation supervised by Mr. Albert L. Webster, consulting engineer. Mr. Cass Gilbert is the architect of the building. The plumbing and water-supply system was installed by the W. G. Cornell Company.

A Subway Project for Genoa, Italy, has been approved by the Superior Council of Public Works of Italy, according to a U. S. consular report. The route will be 6 1/3 miles long; it will be mostly underground, with about 3250 ft. of elevated tracks, and shorter lengths of ground-level tracks and bridge work. Some of the underground portion will consist of covered cuts, but most of it will be tunnel work.

Strength of Drain Tile and Sewer Pipe

Results of a Study of the Causes and Prevention of Pipe Failures, with Conclusions, Based on Experiments, of Loads in Trenches

The value of the annual output of clay drain tile and sewer pipe in the United States in 1910 has been given in a government estimate as $21,818,518. Using this figure as a basis, it has been stated that with the inclusion of cement pipe and the cost of labor and materials it is probable that $75,000,000 are spent annually in this country in the construction of sewers and drains.

In spite of the magnitude of this work the expenditure of millions has largely been based on visual examinations of the pipe or tile and a guess as to the loads which it may be expected to carry safely. With a view of developing a correct method of calculating the loads on pipe and of preparing adequate standard specifications for the quality of drain tile and sewer pipe, the engineering experiment station of Iowa State College, at Ames, Iowa, has conducted a series of experiments and investigations, the results of which are reported in a bulletin by Dean A. Marston and Mr. A. O. Anderson.

FAILURE OF PIPE

The following general conclusions reached by them as to the failure of drain tile and sewer pipe in ditches are based on extensive data obtained from drainage engineers:

1. There have been a large number of failures of drain tile and sewer pipe by cracking in ditches, and there is a wide prevalence of cracked pipe in existing sewers and drains. The cracking is generally confined to pipe larger than 15 in. in diameter. Engineers have not properly appreciated either the extent or the importance, nor have they fully understood the causes, of cracking of drain tile and sewer pipe in ditches.

2. The principal cause of the cracking of the drain tile and sewer pipe in ditches is simply that, as at present manufactured, sizes larger than 15 in. in diameter are very generally too weak to carry the weight resting upon them from more than a few feet depth of ditch filling.

3. In very many cases it is entirely impossible to prevent cracking in ditches of drain tile and sewer pipe as at present manufactured by any possible reasonable amount of care in bedding and laying the pipe and refilling the ditches. A material difference in the carrying power of the pipe, however, can be made by proper care in bedding and laying.

4. Drain tile and sewer pipe crack more readily in ditches with hard bottoms than when laid on slightly yielding soils.

5. It is reasonable, advantageous and necessary to require the pipe-laying contractor carefully to shape the bottom of the ditch to fit the under half of the pipe surface, and to bed the pipe carefully for this distance in sand or granular soil, so as to secure a firm, uniform bearing.

6. Drain tile and sewer pipe are so rigid and crack from such slight distortions, as compared with the yielding of the most solidly tamped earth filling, that it is not feasible to prevent cracking by tamping the ditch filling on each side of the pipe at the midheight. Such side tamping, however, should always be required, and thoroughly done, for it is of great value in preventing the collapse of pipe after it is cracked.

7. Where the pipe is found to crack in spite of faithful observance of the specifications stated in 5 and 6 above, the only effective remedy, other than using stronger pipe, is to bed the pipe in concrete up to the midheight. Such concrete can be lean, and need not be thick if the soil is firm, but must thoroughly fill all spaces between the lower half of the pipe and the bottom and sides of the ditch.

8. The width of the ditch at the level of the pipe makes a great difference in the weight of filling resting on the pipe, this weight being greater the wider the ditch. Moreover, the narrower the ditch at the midheight of the pipe, the more effective is the side support against the collapsing of cracked pipe.

9. Where the ditch filling over the pipe is rammed in layers during refilling, there is serious danger of cracking large drain tile and sewer pipe by using too heavy rammers and too thin a layer just above the pipe.

10. While large amounts of cracked drain tile and sewer pipe are standing without collapsing in existing drains and sewers, the stability of cracked pipe must be considered precarious, as has been demonstrated by numerous collapses.

11. Cracked pipe is especially dangerous in tile drains and storm sewers, for the reason that, in the best engineering practice, it is not found practicable to make the capacity of drains and sewers equal to the most exceptional floods. Hence they are certain eventually to be overcharged, and to run under pressure, and the collapse of cracked pipe is likely to result at such times from the softening of the soil by water escaping through the joints and cracks.

THEORETICAL STRENGTH

The general principles of the theory of loads on pipes in ditches, which were borne out by a long series of laboratory and field tests, have been summarized by Dean Marston and Mr. Anderson as follows:

1. The weight of the filling in a drainage or sewerage ditch, at the time of maximum load on the pipe, is carried partly by the pipe, and partly by friction against the sides of the ditch. Cohesion greatly reduces the loads carried by the pipe at ordinary times, after the ditch is refilled and partly consolidated, except in the case of clean sand, or gravel filling, but does not appreciably affect the maximum loads.

2. The maximum loads on pipes in ditches, due to the weight of ditch-filling materials, will usually occur at the time of the first very thorough surface flooding of the ditch filling after construction, when there is a large settlement of the refill, but there is possibility of their occurring later, at the time of extreme saturation of the ditch filling, by surface flooding of the ditch and by overcharging of the drain or sewer. The maximum loads may even be postponed for many years in some cases, as is frequently shown by settlement of the filling in old ditches during paving construction.

3. Safe values of the ordinary maximum loads on pipes in ditches, due to the weight of ditch-filling materials, can be computed by the formula, $W = CwB^2$, using the values of C given in Table 1, where W = load on pipe in ditches, in pounds per linear foot; C = coefficient of loads on pipes in ditches; w = weight of ditch filling material, from 90 to 120 lb. per cubic foot; B = breadth of ditch at top of pipe, in feet, and H = height of fill, above top of pipe, in feet.

4. In calculating the maximum loads on pipes in ditches, due to the weight of ditch filling, by the formula and Table 1, the value to use for H is the height of the filling above the top of the pipe, and the value for B is the breadth of the ditch a little below the top of the pipe.

5. In ditches of proportions customary in actual work the diameter of the pipe used in any particular ditch, of a fixed, given width, makes practically no difference in the load on the pipe. A 12-in. pipe will have to carry the same load as an 18-in. pipe, if both are placed in ditches 2 ft. wide, under other similar conditions.

TABLE 1—APPROXIMATE SAFE WORKING VALUES OF C, THE COEFFICIENT OF LOADS ON PIPES IN DITCHES

H/B	Damp top soil and dry and wet sand	Saturated top soil	Damp yellow clay	Saturated yellow clay
0.5	0.46	0.47	0.47	0.48
1.0	0.85	0.86	0.88	0.90
1.5	1.18	1.21	1.25	1.27
2.0	1.47	1.51	1.56	1.62
2.5	1.70	1.77	1.83	1.91
3.0	1.90	1.99	2.08	2.19
3.5	2.08	2.18	2.28	2.43
4.0	2.22	2.35	2.47	2.65
4.5	2.34	2.49	2.63	2.85
5.0	2.45	2.61	2.78	3.02
5.5	2.54	2.72	2.90	3.18
6.0	2.61	2.81	3.01	3.32
6.5	2.68	2.89	3.11	3.44
7.0	2.73	2.95	3.19	3.55
7.5	2.78	3.01	3.27	3.65
8.0	2.82	3.06	3.33	3.74
8.5	2.85	3.10	3.39	3.82
9.0	2.88	3.14	3.44	3.89
9.5	2.90	3.18	3.48	3.96
10.0	2.92	3.20	3.52	4.01
11.0	2.95	3.25	3.58	4.11
12.0	2.97	3.28	3.63	4.19
13.0	2.99	3.31	3.67	4.25
14.0	3.00	3.33	3.70	4.30
15.0	3.01	3.34	3.72	4.34
Infinity	3.03	3.38	3.79	4.50

6. The width of the ditch a little below the top of the pipe makes a great difference in the load on the pipe, which is very much heavier for wide than for narrow ditches.

7. In case a wide ditch is necessary for constructive reasons, the load on the pipe can be diminished greatly in firm soil by stopping the wide ditch a few inches above the top of the pipe, and digging in the bottom the narrowest ditch practicable to receive the pipe, making bell holes at the side for the sewer pipe, if necessary.

8. The loads on pipe in ditches, due to the weight of ditch filling, increase for greater depths of fill, but the proportion of the total weight of filling carried by the pipe decreases as the depth increases, and after the depth of fill becomes equal to ten times the breadth of the ditch at the top of the pipe there is practically no further increase in the load on the pipe for greater depths.

9. The loads on pipes in ditches, due to the weight of ditch filling, are directly proportional to the weights per cubic foot of the ditch fillling materials. Of the common ditch filling materials, clay is the heaviest, and black top soil the lightest, sand being intermediate.

TABLE 2—APPROXIMATE SAFE VALUES OF C_l TO USE IN FORMULA $L_{lp} = C_l L_l$

H/B	Sand and damp top soil	Saturated top soil	Damp yellow clay	Saturated yellow clay
0.0	1.00	1.00	1.00	1.00
0.5	0.85	0.86	0.88	0.89
1.0	0.72	0.75	0.77	0.80
1.5	0.61	0.64	0.67	0.72
2.0	0.52	0.55	0.59	0.64
2.5	0.44	0.48	0.52	0.57
3.0	0.37	0.41	0.45	0.51
4.0	0.27	0.31	0.35	0.41
5.0	0.19	0.23	0.27	0.33
6.0	0.14	0.17	0.20	0.26
8.0	0.07	0.09	0.12	0.17
10.0	0.04	0.05	0.07	0.11

10. Grades or fills built over the surfaces of completed ditches, and piles of sand, gravel and other materials having internal friction, operate to increase the loads on pipes in ditches to the same extent as an equal added height of ditch filling, for a breadth of ditch

equal to that at a little below the top of the pipe.

11. A super load is any load applied to the upper surface of the ditch filling, except loads from fills or heaps of granular materials. A long super load is one extending a considerable length along a ditch, as compared with its depth and breadth, and may be caused by piles of paving brick, lumber, etc., over the ditch. Long super loads on completed ditches cause increases in the loads on pipes in ditches by percentages of the super load which decrease as depth increases, and safe values for which can be computed by the formula, $L_{lp} = C_l L_l$, using values of C_l given in Table 2, where L_l = long super load per unit of length of ditch; L_{lp} = load on pipe per unit of length, due to L_l, and C_l = coefficient of loads on pipes in ditches due to long super loads, L_l.

12. A short super load is one extending a short distance along a ditch as compared with the breadth and depth, and may come from the wheels of wagons, traction engines, steam road rollers, etc. Short super loads, on completed ditches, cause increases in the loads on pipes in ditches by percentages of the super load which decrease as the depth increases, and safe values which can be estimated, but not very reliably, by the formula, $L_{sp} = C_s L_s$.

13. Cracking of pipe in ditches is sometimes caused by heavy tamping of the filling material over it, or too thin a cover layer. The pressures transmitted to the pipe by tamping with rammers of different weights, on cover layers of different thicknesses, may be estimated, but only approximately, by the aid of the formula, $T_e = 2TF \div f$, where T = weight of rammer used in tamping; F = height of fall of rammer; f = compression of filling material under one blow of rammer at the end of the tamping, and T_e = the maximum pressure on the earth filling resulting from the shock of a blow of the rammer.

14. Ordinarily ditch sheeting may cause some increase in the loads on pipes in ditches from fresh filling, but does not increase the probable maximum loads unless left in permanently.

15. Freezing, and consequent horizontal expansion of the sides of ditches against the sides of the pipe, sometimes causes cracking.

16. The general effect of the lapse of time after the completion of the refilling is to decrease rather than increase the loads on pipes in ditches, though the maximum loads, as indicated in principle 2, above, generally do not occur until after the refilling is finished.

Tree Windbreaks to Replace Portable Snow Fences

Trees to replace portable snow fences are being tried on a large scale by the Canadian Pacific Railway. Along the main line and within the district broadly defined as lying between Winnipeg, Man., and Calgary, Alta., more than 1,356,200 trees have been planted for this purpose up to December, 1912, by the Forestry Branch of the Natural Resources Department.

The country traversed by the Canadian Pacific Railway in which this equipment is being maintained is largely rolling prairie and the frequent high winds have an unobstructed range over which to drift the winter's snow. Portable fences of a standard type have been employed to arrest the snow and prevent it from drifting into the cuts and blockading traffic. This method has the usual disadvantages of high first cost and continual repairs and maintenance.

As in the case of portable snow fences, the distance of the tree windbreak from the track depends upon the topography at each point and upon the width of right-of-way. In general, however, the inside row is from 75 ft. to 85 ft. from the track.

View Showing Relation of the Trees to the Track

Present Appearance of One of the Tree Windbreaks

The method of planting the windbreaks may be briefly described as follows: The land is broken and backset the first year, subsoiled the next, and planted the third. The planting crew consists of a foreman, twelve laborers, a cook, and two teamsters to each camp. The laborers are divided into three-man groups. In this way one man digs the holes, another places the trees in position and packs the earth firmly around their roots, and the third fills in the earth to a little above the old nursery mark, packs it around the trees and levels the ground at each side of the row. This method was found to be the fastest and most satisfactory, as the foreman could then check over each group's work.

The young trees, which were grown in the Canadian Pacific Railway Company's nursery at Wolseley, Sask., were all baled in gunny sacks and sent by baggage or freight to the station nearest the camp. The man placed in charge of each car was supplied with two or three barrels of water, which he used to keep the roots moist while in transit. As soon as the trees were received they were heeled in and after sundown distributed by wagon to each plantation, where they were again heeled in for the next day's work. When the trees were taken out next day for planting they were carried in a pail or tub containing a puddle of earth and water.

Manitoba maple, Russian poplar, cottonwood, laurel-leaf willow, red willow, golden willow, ash and spruce are the species of trees which have been planted. Two species of shrubs were also planted—Caragana and Artemesia. All trees were two to three-year-old transplants and would vary from 24 to 36 in. in height. Up to the present time the loss or renewal has not exceeded 10 per cent.

The trees have been planted 4 ft. apart in the rows and 7 to 8 ft. between rows, leaving a cultivated strip 8 ft. wide around the plantation. This reduces the cost of cultivation, as the trees quickly spread foliage and by shading the ground soon kill the weeds. With the rows 7 or 8 ft. apart there is plenty of room for a disk harrow to be worked between them, thus saving much time which would be wasted if small one-horse cultivators were used.

Two furrows have been plowed on each side and across the ends of these plantations, thus making a fire guard of about 20 in. and a cultivated piece of more than 8 ft., or in all a strip of nearly 10 ft. in width around the plantation. Experience has shown that ground fires in this locality will not jump such a fire guard, or even injure plants within it.

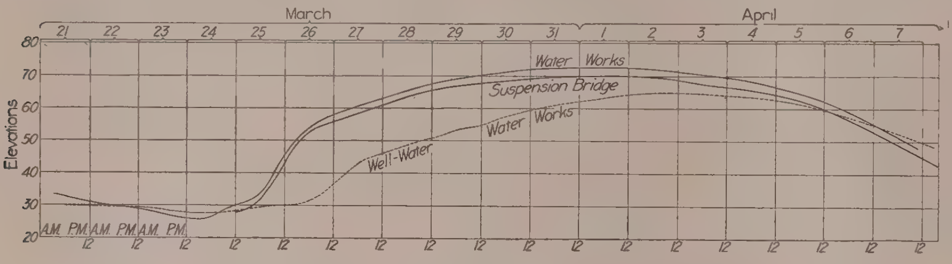
As yet the saving in cost between portable fences and tree windbreaks is very indefinite. The trees first set out in 1908 were only high and strong enough to remove the portable fences during the fall of 1912, and owing to the light snowfall during the past winter little information as to relative value of trees and fences as snow barriers has been available to those interested.

Bids for 300,000,000 Ft. of Timber which had been advertised for sale by the U. S. Forest Service on the Tongass National Forest in Alaska have been received, and the same amount in addition from the same forest has been applied for. The timber is largely Sitka spruce, which will be made into paper pulp. It is estimated that there are about 70,000,000,000 ft. on the Tongass National Forest, and 28,000,000,000 ft. on the Chugach National Forest in Alaska, the two constituting approximately one-sixth of the total stand of timber on the national forests. The first cutting from the Tongass forest was done in 1902. In that year about 43,000,000 ft. were cut.

Flood and Rainfall during March and April at Cincinnati

By J. W. Ellms, Superintendent of Filtration, Cincinnati Waterworks, Cincinnati, Ohio

The two heavy rainstorms which passed over the Ohio River Valley between March 23 and 28, 1913, followed each other so closely that the rain areas of the two merged into each other and produced a practically continuous precipitation of water over the same portion of the Ohio valley. This peculiar meteorological condition was the cause for the tremendous runoff from the northern tributaries of the Ohio River, and the one which made the latter stream itself rise to a height which has only been exceeded once or twice before. In 1773 the river is said to have risen to a height of 76 ft. above low-water mark, but the record is not authentic. In 1884 the river rose to a height of 71.06 ft., and on April 1, 1913, it reached the height of 69.8 ft.



Gage Readings at Cincinnati from March 20 to April 8

RAINFALL

From March 23 to 27, both inclusive, the total rainfall in the towns and cities on the watershed of the Ohio River, as shown in Table 1, is sufficient evidence to account for the extraordinary flood conditions which prevailed.

TABLE 1—TOTAL PRECIPITATION IN FIVE DAYS

Place	Rainfall In.	Place	Rainfall In.
Bangorville	9.5	Delaware	7.5
Canal Dover	5.8	Marion	10.6
Canton	8.4	Waverly	4.6
Granville	7.2	Bellefontaine	11.2
Marietta	2.7	Cincinnati	7.5
Newport	5.7	Dayton	7.6
Philo	6.3	Greenville	9.3
Warren	8.3	Sidney	8.8
Wooster	10.1	Urbana	8.5
Circleville	6.4	Waynesville	7.7
Columbus	6.9		

In previous issues of the Engineering Record may be found the flood heights of the northern tributaries of the Ohio River at various points. In the accompanying diagrams may be seen the height of the flood in the Ohio River at Cincinnati and its immediate vicinity.

The writer estimated from data obtained from various sources that at the maximum height of the Ohio River (69.8 ft.) the volume of water passing the city at the Suspension Bridge was approximately 800,000 sec.-ft. When this is compared with the minimum flow of approximately 5000 sec.-ft. the enormous volume of water which passed down the stream during the flood stage can be better appreciated. In passing it may be pertinent to point out that the handling of this immense volume of water from the time it begins to run off the surface of the ground into the small streams and the time it has grown to such a volume as to overflow the banks of these streams and of the main stream to which the former are tributary is the real problem of the conservation of stream flow. Unless immense reservoirs are provided having a capacity equal to and immediately available for storing and controlling these volumes of water, a great deal of it must necessarily go to waste.

The rise of the Ohio River at Cincinnati began on March 24. On the 25th and 26th it rose 21.3 ft. in twenty-four hours. The greatest rise in one hour was 1.6 ft.. This twenty-four-hour rise at a stage above 30 ft. exceeded the previous highest recorded twenty-four-hour rise in 1883 by 4.9 ft. The flood in 1884 rose to a height of 71.06 ft. Owing to a difference in the elevation of the zero marks of the gages used in 1884 and in 1913 the real difference in the flood heights at the maximum was probably about 1.56 ft.

STREAM CONDITIONS

On the diagram showing the rise and fall of the flood the solid lines show the elevation at the Cincinnati waterworks pumping station at California, Ohio, and at the Suspension Bridge nearly opposite the center of the city. The distance between these two points by river is approximately 40,950 ft. Both the Little Miami and the Licking River empty into the Ohio River between these two points. In this connection the hydraulic slope of the stream is of interest, as it exhibits some peculiarities. This is brought out on the diagram showing the profile of the stream at the flood stage. The rather sudden drop in the curve at Waldon Street would seem to indicate the spreading out of the water on the low lands at the mouth of the Licking River, and a little farther down on the low lands of Mill Creek. The immense volume of water crowded into the relatively narrow part of the river opposite Columbia would tend to hold the water more nearly level in this portion of the stream, while causing a rather sudden drop of the gradient as the stream widened out below.

Flood Stage at Cincinnati

Ohio River During March-April, 1913, at the Waterworks River Pumping Station

Differences in river levels between a point near the present river pumping station at California, Ohio, and the old Front Street pumping station in the city for three different floods are shown in Table 2.

The fall in the river between these two points in 1884 was apparently not quite as much as in 1913, but is probably explained by the fact that in 1884 no embankment existed which at present connects the river pumping station with the high land back from the river, and which now narrows the channel during flood stages very materially. This narrowing of the channel would have the effect of raising the water level slightly at this point, and thus producing a somewhat greater difference in the fall of the stream than existed in 1884.

TABLE 2—DIFFERENCES IN RIVER LEVELS

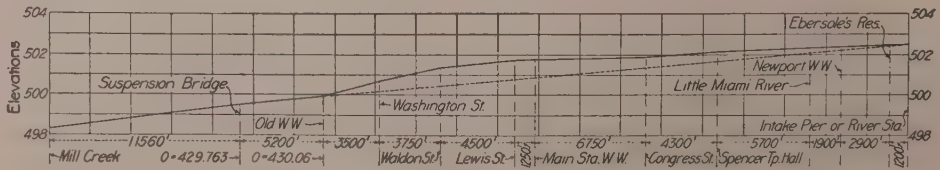
	River Floods in 1884, Ft.	River Floods in 1898, Ft.	River Floods in 1913, Ft.
Maximum height of water	71.06	61.40	69.80
Fall in distance of 34,550 ft. Between points noted	2.52	2.40	2.57

On the diagram showing the rise and fall of the flood is a broken line indicating the rise and fall of the ground water in a well at the river pumping station. It is interesting to observe under the abnormal conditions of the rapid rise of the surface water how the ground water level lags behind. It follows it quite closely, however, and assumed the normal relation to the surface water level as the flood water began to fall.

Filing Case for Street Profiles

In the office of the city engineer of Lima, Ohio, there has been in use for a number of years a damp and dust proof filing cabinet for profile drawings and blueprints for streets and street improvements that are too long to file flat. The cabinet, which is of somewhat unusual design, has proved satisfactory as to facility of operation and economy of space. The cabinet as originally designed was of wood, paneled, and with a set of glass doors, closely resembling the less modern type of bookcases common a generation ago. As built, however, the paneling and glass doors were left off. The cabinet is 7 ft. high, 4 ft. 8¾ in. wide, and 2 ft. 2 in. deep. An upper portion, 3 ft. 6 in. wide by 4 ft. 5 in. high, contains one hundred and eighty tin tubes or cans, arranged in twelve columns and fifteen rows, that hold the profile rolls. The portion below has three drawers, each 5 in. deep, extending the entire width of the cabinet. Each tube or holder is 21 in. long and 2⅞ in. in diameter. It fits closely in a tin casing 23 in. in length and 3 in. in diameter, which is soldered front and back to tin sheets. The front tin sheet is pierced with holes cut out to the diameter of the tubing. A small hole has been bored through the back of the cabinet at the center of each tube to allow the admission and discharge of air when the containers are inserted or pulled out.

The profiles of each street are arranged in the cabinet alphabetically, labels being attached to the cover of each container. At the right end of each row a single container is left empty for the use of new profiles.



Profile of the Ohio River Flood Stage on April 1, 1913

Port Improvements at San Francisco

General Description of Past, Present and Proposed Developments

By Frank G. White, Assoc. M. Am. Soc. C. E., Asst. Engineer, Board of State Harbor Commissioners

In anticipation of the large increase in shipping which is expected with the opening of the Panama Canal the port facilities of San Francisco are being greatly improved and extended. While the improvements contemplated will not all be completed by the time the canal is open for business, the work will be carried on fast enough to furnish accommodations as needed.

The peculiarly advantageous location of San Francisco, with its wonderful harbor and its railway and steamship lines reaching out to the Orient, north and south along the Pacific Coast and east across the continent, is too well known to call for more than passing mention. An added advantage is that the waterfront is not in the hands of private individuals or powerful corporations, but belongs to the state of California and is administered by the Board of State Harbor Commissioners.

The port has always been self-supporting, but has been seriously handicapped in the past by lack of funds for harbor improvements. Between 1863 and 1910 a total of $14,230,000 had been spent, the greater part from the income of the harbor itself. In 1909 and 1910 two bond issues were authorized, one of $9,000,000 for harbor improvements and one of $1,000,000 for purchasing tide lands to be held until needed for future extensions.

Types of Pier Foundations

In the beginning the piers and wharves were constructed of timber on untreated piles, but the prevalence of the teredo and limnoria in the waters of the bay made it imperative that the piles be preserved or protected in some manner. Various chemical treatments were tried with varying success. Creosoting was found to be the most satisfactory, good creosoted piles lasting from ten to twelve years. Several methods of protection involving the use of tar or asphalt paints, brushed on and covered with canvas and redwood battens, were tried with indifferent success.

A number of piers were constructed on piles protected by depositing concrete around them inside of cylindrical wooden stave forms. Where the forms were driven to a sufficient depth, pumped out dry and the concrete reinforced with steel bars or wire fabric, this method has apparently proved effective. In some cases, however, the cylinders were not carefully pumped out, the result being that there was separation of the cement when the concrete was dumped through the water. In some cases also the reinforcement was omitted; in many places, from one cause or another, the concrete has fallen away, leaving the piles exposed to the attacks of the teredo and limnoria.

Another method of protecting piles which has been used with apparent success is that of placing over the piles previously cast reinforced-concrete cylinders, pumping out the annular space, and filling it with concrete or mortar. The cylinders have been made with a 3-in. shell, the inside diameter being from 4 to 6 in. larger than the diameter of the pile butt.

From the two types of construction last mentioned was developed the method being used to some extent at present. Along some portions of the waterfront it is possible, without going to too great a depth, to reach rock, hardpan or mixtures of hard clay and sand which will safely carry loads of at least 5 tons per square foot. Where this hard bottom can be reached the piles are eliminated entirely, solid reinforced-concrete cylinders with enlarged bases being used. Cylindrical steel caissons are driven to hard bottom and dredged and pumped out so that the concrete can be placed dry. The excavation is carried at least 1 ft. into the hard bottom and the concrete is then deposited in wooden stave forms. The cylinders are from 3 to 4 ft. in diameter and the bases are up to 8 ft. 6 in. in diameter. The steel caissons are pulled when the concrete is one or two days old. Where the hard bottom cannot be reached a sufficient number of piles are driven inside the caisson and cut off at such an elevation that the heads will be embedded in the bases of the cylinders.

Development before 1911

When the present state administration came into office in 1911 an entire new board of state harbor commissioners was appointed. This board found that of the 10 miles of waterfront under its jurisdiction about 4 miles had been improved to a varying degree. There were in existence twenty-six main piers and several minor ones in various conditions of repair, about 3 miles of rock sea wall, the ferry building and eight passenger-ferry slips, three car-ferry slips and the Belt Railroad in two unconnected sections. Of the twenty-six piers, four were constructed on solid reinforced-concrete cylinders and one on protected piles, in the construction of which proper precautions had been taken to secure good work. Nine were on wooden piles and were in need of constant repair. Twelve had been constructed on some type of protected piles, but the work had been poorly done or the lowering of the mud level by dredging had permitted the entrance of the teredo. Whatever the cause, not one of these twelve piers was in first-class condition, and some in fact required immediate attention.

With the time of opening the Panama Canal approaching and shipping expected to increase rapidly, with steamship companies asking for permanent berths, and with twenty-one piers in more or less unsatisfactory condition and only five really first class, the following policy was outlined: The existing piers were to be kept in commission as long as possible by making the necessary urgent repairs. As fast as practicable new piers were to be constructed along unoccupied portions of the waterfront and as it became necessary the old piers were to be replaced with new ones.

At that time only eight piers had spur tracks connected with the Belt Railroad, and a large part of the railroad business was the switching of cars between the car ferries, industry tracks and railroad yards. As there was a demand for rail connections on the piers, it was decided that all new piers should be so equipped, and as a preliminary step spur tracks were extended alongside three of the existing piers. The results have been very satisfactory, the income from these tracks being amply sufficient to justify their construction.

Regarding mechanical freight-handling machinery, the board has adopted a conservative policy. Certain piers and pier sheds which have already been assigned will be built in accordance with the wishes of the prospective tenants so that they may install such equipment as seems best adapted to their business.

Other piers will be constructed in such a way that whenever it seems advisable almost any type of equipment may be installed either by the tenants or by the board. Some of the steamship companies contemplate the installation of semi-portal cranes outside the sheds, which will take cargo from the ships' hatches and land it on the pier in front of the doors where it can be reached by the outrigger of a crane inside the shed. Some expect to install overhead monorail trolley or telpher systems and others may use motor trucks operating through the side ports of the ships.

Pier 17

The first permanent improvement undertaken was that of replacing Pier 17, which was entirely out of commission. A new layout for the waterfront between the ferry building and the car ferries at Lombard Street was worked out, providing for the ultimate replacement of all of the existing piers. The new pier 17 was built in accordance with this new plan and is now completed and in commission. It is 126 ft. wide by 800 ft. long and has a railroad track down one side. It is supported on wooden piles protected by previously cast reinforced-concrete cylinders. The caps are steel I-beams incased in concrete and the stringers and planking are timber. The shed is a timber structure 100 ft. wide. This contract included a section of bulkhead wharf adjacent to the pier 40 ft. wide by 325 ft. long, supported on reinforced-concrete piles with a reinforced-concrete deck paved with asphalt.

The next work undertaken was the construction of four piers along the unoccupied portion of the waterfront between Brannan and Harrison Streets. These piers, which are numbered 26, 28, 30 and 32, are identical as to type of construction. They are built on reinforced-concrete cylinders resting on enlarged bases on hard bottom, and the decks consist of reinforced-concrete girders, beams and slabs.

Each pier has a railroad track down each side, one track being flush with the deck and the other being depressed so that the car floor will be at about the level of the deck. The shed on pier 28 is a steel-frame structure with concrete curtain walls and roof. The sheds on piers 26, 30 and 32 are timber structures, except that the outside columns are of steel. These three sheds are equipped with crane girders and rails inside and ship-crane girders and rails outside, and the tenants expect to install the most modern freight-handling machinery. The door openings in the sides of the sheds are continuous and are fitted with steel rolling doors.

Work on the four piers in this group is progressing satisfactorily, and it is expected that they will all be ready for occupancy before the end of the year.

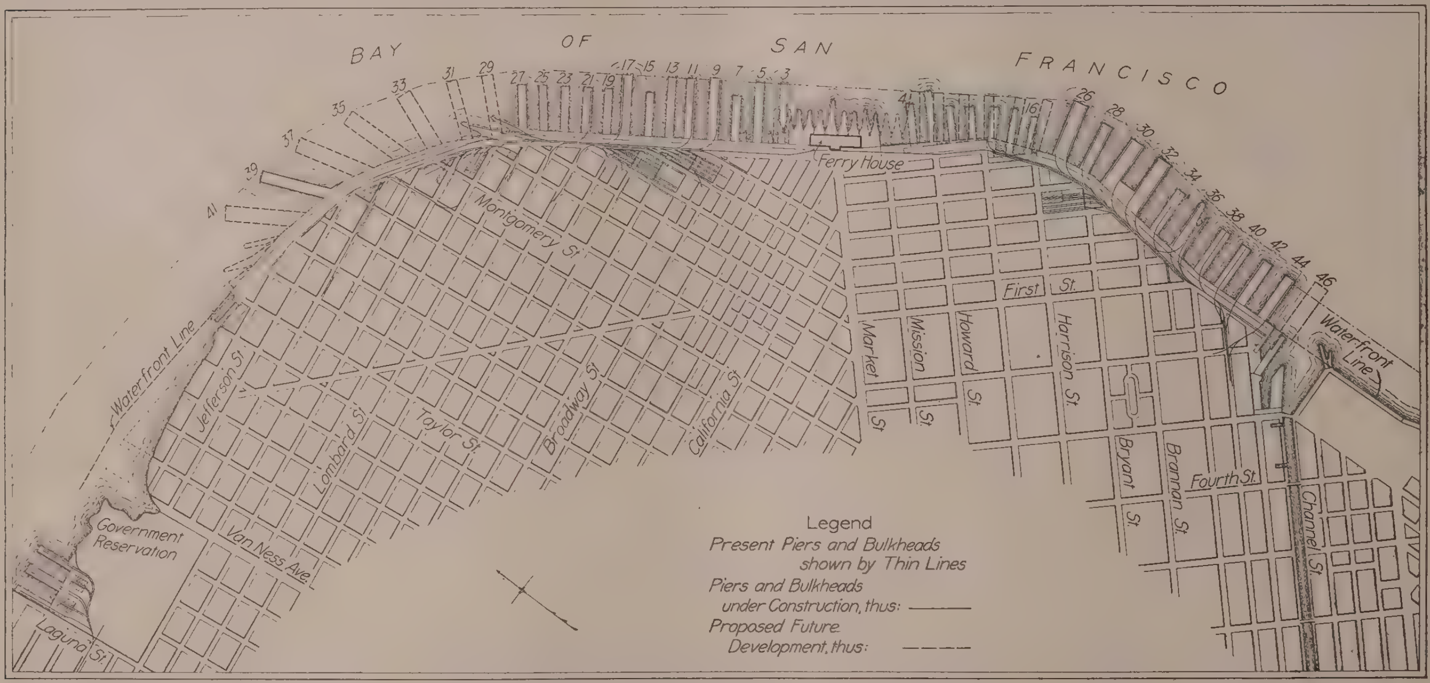
North Waterfront

It was next decided to undertake the improvement of the waterfront between pier 27 at the foot of Lombard Street and the foot of Taylor Street. A number of general plans were worked out, but the one shown on the map was finally adopted. It provides for the removal of the existing car-ferry slips at Lombard Street and the construction of seven piers and two new car-ferry slips. Three of the piers are to be 150 ft. wide each and are to have two-story sheds, the second floor being fitted with accommodations for passengers. The other four piers are each to be 200 ft. wide, and all except pier 41, are to have one-story sheds.

Of this group the contract has been let for pier 39, which is now under construction. The type of construction is the same as that used for the group just described, with the exception of the foundations. The bottom at the site of pier 39 is not sufficient to carry the required loads at reasonable depths. The cylinders and bases are therefore carried on clusters of wooden piles, from four to ten piles being used in a cluster. The piles are driven well below the dredge line inside the caissons and the heads embedded in the concrete bases. There is to be a railroad track along each side of the pier outside of the shed, one track being flush and one depressed. The shed is to be a two-story structure, the first story for freight and the second for passengers and baggage.

None of the other piers in this group is under construction, but the plans are now being prepared and contracts will be let from time to time.

As it will be necessary in the near future to replace the piers between the ferry building and pier 26, and as several new ferry slips are needed, a new layout was worked out for the improvement of that portion of the waterfront. This provides for the construction of five new piers and three new ferry slips and for the rebuilding of one old slip. Of this group it is proposed to proceed with the construction of the ferry slips and the two northerly piers, and the plans are now in course of preparation. These piers are to be of timber construction on creosoted piles and will be equipped with spur tracks connected with the Belt Railroad.



Plan of San Francisco Waterfront, Showing Railroad Connections and Location of Present and Future Piers

Sea Wall

Another important piece of work which has been undertaken is that of extending the sea wall and permanent bulkhead wharf from the end of section 8 between Mission and Howard Streets to section 9 at Harrison Street, a distance of about 1770 ft. The sea wall consists of a loose-rock embankment extending from about 38 ft. below to about 7 ft. above low water. At its crest is a concrete retaining wall supported on piles and extending from about 1 ft. below low water to about 12 ft. above, or to the street level. The bulkhead wharf extends from this retaining wall to the waterfront line, a distance of 60 ft. It consists of concrete piles and protected piles, I-beam caps and stringers and a wooden deck covered with asphalt pavement. This work is under construction and when it is completed the sea wall will be continuous from Taylor Street to Channel Street.

The Belt Railroad, which has been operated for some time in two separate sections, was recently connected from Bryant Street on the south to Broadway on the north, and the transferring of cars on floats from one side to the other is now unnecessary. Plans are now being prepared for the extension of the Belt Railroad by way of Jefferson Street and a tunnel from Van Ness Avenue to Laguna Street, under the government reservation, to the U. S. Army transport-service docks and the Panama-Pacific Exposition site, which are now without rail connections.

It is believed that with the addition of the improvements which will be completed by 1915 the increase of business expected with the opening of the canal can be handled satisfactorily. The berthing space will be increased by about 60 per cent and the pier area about 100 per cent over the accommodations at the present time.

The cost of the work under construction is about as follows: Pier 17, $286,000; pier 26, $608,000; pier 28, $460,000; piers 30 and 32, $1,232,000; pier 39, $500,000, and sea wall, $544,000. The other work mentioned will probably exhaust the bond issue of $9,000,000 and the legislature has been asked to authorize another bond issue of $10,000,000 to be used as needed for future extensions.

The present Board of State Harbor Commissioners consists of President J. J. Dwyer and Messrs. Thomas S. Williams and J. H. McCallum. Mr. A. V. Saph, M. Am. Soc. C. E., was chief engineer until August, 1912, and under his direction the plans were prepared and construction started on piers 17, 26, 28, 30 and 32. Mr. Saph was succeeded by Mr. Jerome Newman, M. Am. Soc. C. E., and under his direction the construction of the piers has been carried on and the Belt Railroad connected across Market Street. Plans have been completed for piers 39 and 46 and for the car ferries and the sea wall, and work has been started on the construction of pier 39 and the sea wall.

Code of Ethics of the Pacific Northwest Society of Engineers

The following code of ethics was adopted by the Pacific Northwest Society of Engineers at its annual convention in Seattle June 20:

It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any engineer:

1. To act for his clients in professional matters otherwise than in a strictly fiduciary manner or to accept any other remuneration than his direct charges for services rendered his clients except as provided in Clause 4.

2. To accept any trade commission, discounts, allowances, or any direct profit or consideration in connection with any work which he is engaged to design or to superintend, or in connection with any professional business which may be entrusted to him.

3. To neglect informing his clients of any business connections, interests, or circumstances which may be deemed as influencing his judgment or the quality of his services to his clients.

4. To receive, directly or indirectly, any royalty, gratuity or commission on any patented or projected article or process used in work upon which he is retained by his clients, unless and until receipt of such royalty, gratuity, or commission has been authorized in writing by his clients.

5. To offer commissions or otherwise to improperly solicit professional work, either directly or by an agent.

6. To attempt to injure falsely or maliciously, directly or indirectly, the professional reputation, prospects, or business of a fellow engineer.

7. To take over the work of another engineer unless and until the client has given notice of such transfer and the reason for same to the engineer in charge, and the engineer has communicated with the engineer in charge in order that there may be no bad feeling caused through misunderstanding.

8. To attempt to supplant a fellow engineer after definite steps have been taken toward his employment.

9. To compete with a fellow engineer for

employment on the basis of professional charges by reducing his usual charges and attempting to under-bid after being informed of the charges named by his competitor.

10. To accept any engagement to review the work of a fellow engineer for the same client, except with the knowledge or consent of such engineer, or unless the connection of such engineer with the work has been terminated.

11. The first duty of engineers is to their clients or employers, who have a right to expect that the portion of their business entrusted to the engineer will receive careful investigation and intelligent treatment.

12. An engineer should not attempt work with which he is unfamiliar. Consultations should be encouraged in cases of doubt or unusual responsibility. The aim should be to give the client the advantage of collective skill. Discussions should be confidential.

13. Engineers in their professional relations should be governed by strict rules of honor and courtesy, and their conduct toward each other should be such as to secure mutual confidence and good will. They should give other engineers the advantage of publication, wherever possible, of any unusual or interesting feature of their practice.

(*a*) All communications should be made through a responsible head, unless another has been designated to act for him.

(*b*) Services of an assistant to an engineer should not be secured without first communicating with the principal to ascertain if such action will interfere with his work.

(*c*) An assistant should not accept employment with another engineer without first consulting his superior.

(*d*) A superior should not stand in the way of advancement of a subordinate.

(*e*) The criticism of another's work should be broad and generous.

(*f*) The attitude of superiors should be that of helpfulness and encouragement. The attitude of subordinates to superiors should be one of loyalty free from captious criticism. The treatment of each by the other should be open and frank.

14. The engineer should be willing to assume his proper share of public work and render such assistance as is possible for the general good of the community.

15. The attitude of engineers toward contractors should be one of helpful co-operation and tactfulness, combined with just and firm criticism. They should assume a judicial attitude toward both parties to the contract.

16. Engineers acting as experts in legal or other cases, in making reports and testifying, should not depart from the true statement of results based on sound engineering principles. To base reports or testimony upon theory not so founded and thereby produce erroneous results, is highly unprofessional and brings discredit on the profession, and upon the engineer guilty of such conduct.

Bags of Cement Are Handled on wooden skips at one of the concrete plants on Section 15 of the Lexington Avenue Subway, New York, by the derrick used for delivering buckets of sand and gravel to the concrete mixing machine. The bucket is permanently attached by a clevis connection to the derrick boom hoisting tackle and the skip chains are merely hooked to the edges of the bucket, and the bucket, either empty or full, serves as an evening bar for the skips and enables the latter to be quickly connected and disconnected without the trouble of changing the attachment to the hoisting tackle.

Private Fire-Protection Service Charges

An inquiry to ascertain current practice in this country in relation to charges for fire protection has led Mr. Leonard Metcalf, consulting engineer, of Boston, to characterize present methods as variable and illogical, and in the paper which he presented at the Minneapolis convention of the American Waterworks Association, held June 23-28, he discussed in detail the general principles underlying this subject, the results of a circular inquiry among 2500 waterworks officials, and the conclusion reached by the more conservative fire-insurance engineers as to the service required.

Summary of Conclusions

1. There is no standard practice to-day, Mr. Metcalf concludes, among waterworks in the United States with reference to the character of or charges for private fire-protection service.

2. The "Rules of the National Fire Protection Association," relating to size and arrangement of service connections from public-water supplies to private fire-protection systems as applied to isolated and to congested city risks, appear conservative and worthy of trial if the insurance companies will only leave their interpretation to an independent board or committee of competent and judicially minded fire-protection engineers, rather than to their local insurance agents, and will agree to a conservative interpretation of the right to use larger service connections than a 4-in. maximum contained in their rules.

3. While in the majority of cases 4 in. is a desirable maximum limit for the diameter of private fire-service connections or pipes, particularly in the congested or thickly built-up sections of the community, and while it is desirable that greater capacity should be gained by adding other 4-in. service pipe connections or units rather than by increasing the diameter of the connection, it is recognized that in some cases, more particularly in large and well-isolated risks, service pipes of larger diameter can safely be approved.

4. The private fire-protection service should be absolutely independent of the industrial, commercial or domestic service and should be limited to use for fire-fighting purposes.

5. The private fire-protection service should be equipped with a connection for pitometer readings, with valve and metered by-pass, or with a detector meter of some kind, for inspection and detection, or metering of consumption, resulting from leakage, waste or use of water, as local and financial considerations shall show to be expedient or necessary.

6. Past experience in different communities indicates clearly that abuse of privilege may be successfully controlled by the following methods, which may advantageously be applied successively, if the minimum cost of furnishing private fire protection service is desired: (a) Use of seals upon hydrants, blow-offs and other gated connections, coupled with periodic inspection by the water department and agents of the insurance companies; (b) periodic inspection coupled with the use of pitometer or metered by-pass upon the service; (c) use of detector meters, particularly in installations where the added cost of the meter will not be burdensome.

7. The question as to whether or not a charge should be made for private fire-protection service depends largely upon local conditions and circumstances. There is good ground in equity for urging, on the one hand, that no charge should be made for such service in addition to the charge for public fire-protection service, and, on the other hand, that a moderate charge, based on the cost of the special service rendered, together with the additional cost of inspecting private fire-protection services, would not be inequitable or burdensome. In some cases, as in payments for public fire-protection service, the charge is commensurate with its cost, and probably in many other cases as a matter of expediency in encouraging the installation of private fire-protection connections and devices for the better protection of the community against hazard of fire it is believed to be desirable that a nominal charge only should be rendered for private fire-protection service.

8. If a nominal charge only is made for private fire protection service it should cover:

First, cost of cutting into the street main and making the necessary connection from it to the property line; the insertion of additional gates at the ends of the street block upon which the service is located, if such gates are not already in place; the insertion of a gate advantageously located upon the service; the installation upon the service either of a gated by-pass with small meter upon it or of a detector meter or other device for detecting or recording flow.

Second, cost of a system of double check valves with pet-cocks between them to test their tightness, if another source of supply which may be polluted is connected with the service, and if such a system of check valves may be counted upon under existing conditions to safely protect the public supply. If not, the two sources used should be upon independent service pipe lines.

Third, cost of water used or lost by leakage upon the service.

Fourth, cost of maintenance, depreciation and interest upon the service if the latter is not paid for by the insured when installed.

Fifth, cost of maintenance, depreciation and interest upon such portion of the waterworks plant as may have been necessitated by the demands of the private fire-protection service alone, and which is in excess of the capacity required for the domestic, commercial and public service, including in the latter public fire-protection service.

Sixth, cost of periodic inspection, reading of meters, testing devices, etc.

Seventh, cost of maintaining inspectors in large cities, whose duty it shall be to be thoroughly informed as to the location of all private fire-inspection services, to inspect them frequently and to attend all fires. In the case of smaller works, this work naturally would be done at intervals by the regular operating force. Under such circumstances its cost should be equitably charged to the private fire-protection service. Those charges, except the third item, which covers the cost of the water used, should be made independently of and in addition to the charge for the water actually used.

9. The distribution of the charge levied for private fire protection service can, perhaps, most simply, directly and equitably be levied as an annual service charge for each service pipe connection, increasing the amount of the charge with the pipe diameter.

Remodeling Sewage Works at Manchester, England, is involved in a plan contemplating the expenditure of $5,000,000, according to a report from Vice-Consul John W. Thomas. It is proposed to alter the Davyhulme sewage works, which have an area of 221.5 acres.

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Method and Apparatus for Determining Consistency

With a view to finding a simple yet reasonably accurate method of determining consistency of rather wet concrete investigations were carried on within the last year under the direction of Mr. Cloyd M. Chapman, engineer in charge of the laboratory of Westinghouse, Church, Kerr & Company, New York. The reasons leading up to the studies were stated, in substance, by Mr. Chapman before the meeting of the American Society for Testing Materials, on June 26, as follows:

The need of a method for the reasonably accurate determination of the consistency of neat cement paste, lime paste, cement mortar, lime mortar and concrete has been felt for a long time. The Vicat needle has served its purpose in the testing of cement, and, with its only rival, the "ball test," has furnished the most accurate simple means of determining the consistency of neat Portland cement paste. Neither the needle nor the ball method has been successfully applied to lime paste or to mortars, and neither can be used at all with concrete. In fact, there is now no method in general use in this country for determining with any accuracy the consistency of concrete, nor is there any way in use of describing a consistency except in broad descriptive terms such as "dry," "wet," "sloppy," "mushy," etc.

In the case of cement-sand mortars using other than standard Ottawa sand it has been customary to determine the consistency in a very roundabout way. First the percentage of water required to make a paste of standard consistency with the particular cement used is determined by the Vicat needle or by the ball method. By the aid of the table prepared by the American Society of Civil Engineers is determined the percentage of water which shall be used and a mortar is made up of a 1:3 mixture of cement and standard Ottawa sand of standard consistency. Then by making up a mixture of the sand and cement to be tested, the operator may guess when he has the same consistency as the standard sand mortar.

As the necessity for testing all sand to be used in important concrete work is becoming more fully realized, there is an increasing demand and necessity for a method of determining the standard consistency to which mixtures of cement and the sand to be tested shall be mixed. Another demand for such a method arises from the increasing favor in which tests of concrete are held. A method is needed for standardizing consistency so that results may be more clearly duplicated and conditions reproduced.

New Method Described

The method, as Mr. Chapman described it, consists in depositing the mortar or concrete in a form of suitable size and shape resting on a non-absorbent surface, such as glass or metal, and then removing the form and noting the settling or sloughing down, either with or without the assistance of a jar or shock, of the unsupported mass of paste, mortar or concrete left standing.

The size and shape of the form used depend upon the consistency to which it is desired to bring the material being tested, a low form of large area being used for soft, wet mixtures, and smaller, taller forms for dryer mixtures.

For concrete containing coarse aggregates it is advisable to use a form at least twice the greatest dimension of the largest pieces. In case of stiff pastes or dry mortars or concrete it is necessary to jar or shock the mass in order to produce an appreciable settlement.

A very definite consistency for a wet concrete mixture, Mr. Chapman states, may be determined as follows: A smooth circular metal form, 5 in. high, slightly tapering from end to end, about 3 in. in diameter at one end, 2⅞ in. at the other, and open at both ends, is placed on a glass plate, with the larger end down, filled with the concrete to be tested, and the top leveled off. The metal cylinder or form is then carefully lifted and the concrete allowed to either support itself if dry enough to do so, or to settle down if wet enough to flow, the consistency desired being such that the concrete will just start to settle or slough off when the form is lifted. If it stands erect and holds its shape without change, it is too dry. If it sinks to a heap it is too wet. If incipient settling or sinking takes place, the consistency is that sought.

Apparatus for Stiff Mixtures

When the desired consistency is so stiff that no flow takes place when the form is removed, or if the material under test does not readily slip out of the form, then a membrane liner is used inside the form and jarring is resorted to, in order to make the material under test settle or flow, so as to permit of measuring the amount of that flow.

The membrane used may be thin hard rubber of such size as to just line the inside of the mold. This liner is placed inside the form before it is filled. After filling and removing the form the plate on which the test rests is lifted a definite height and allowed to fall. One of the methods by which this jarring may be accomplished is by inserting under one edge of the glass plate an object of the exact height that it is desired that the plate shall fall, and quickly withdrawing it.

The jar or shock causes the paste or mortar to settle somewhat, and so increase its circumference. This increase in circumference is indicated by a gapping open of the ends of the membrane at the joint by a definite amount for a given consistency. If the gap is less than the proper amount, the mixture was too dry; if more, it was too wet.

As this opening of the liner is the indicator of the proper consistency, it is desirable that ready means be provided for measuring it. This may be accomplished by making the liner or a portion of it somewhat longer than the circumference of the form and allowing the ends to lap each other. One end of the liner is marked off in equal small divisions and the other end of the liner is arranged so as to make it convenient to read the amount of spreading near the bottom of the specimen. It is convenient also to measure the opening with a scale near the bottom. Under some conditions the liner opens somewhat as soon as the outer form is removed, which makes it necessary to read the amount of this opening before jarring and deducting it from the final reading to get the amount of movement due to the jar.

Details as to Method

A number of materials have been tried in the search for a suitable liner. Oiled or waxed paper is satisfactory with lime putty but not with cement. Thin sheet celluloid works well with lime putty and neat cement but not with cement mortar. Thin hard rubber seems to be the most satisfactory of the materials so far tried. It is smooth and flexible and is easily formed from the flat sheet into the desired cylindrical shape with the aid of moderate heat.

There are many details of the method which must be standardized for any particular consistency in any particular material or mixture. A normal neat cement paste placed in a 2-in. diameter mold 2½ in. high, when dropped ¾ in. on a 4 x 12 in. glass plate, will increase its circumference, or cause the liner to open, about one eighth of an inch. An excess of water of 1 per cent will give an opening of greater amount, while 1 per cent less water will produce an opening of less amount.

Dropping Apparatus

There are many conditions under which it is not practical to use the very crude jarring method above referred to, owing to the drop not being sufficient to jar the mass of material enough to produce the desired settling and consequent opening of the liner. A simple apparatus has therefore been devised by means of which the specimen may be dropped from any height up to 12 in. This apparatus consists of a platen for receiving the specimen sliding on vertical guides so arranged that the platen may be raised to the predetermined height and held there by a catch on one of the guides. Releasing the catch allows the platen carrying the specimen to fall, so producing the desired shock.

The diameter and height of the specimen are details of considerable importance. At the present time a diameter of about 2 in. and a height of 3 in. are being used for neat cement, lime putty, cement mortar and lime mortar. It may be found desirable to modify these dimensions somewhat after a wider experience has been gained in the use of the method.

Results Obtained

Numerous tests of the method here described have been made on various materials and the results, Mr. Chapman states, have indicated that with proper standardization it may be adapted to many of the uses for which there is at present a demand for a suitable method. It has been used for several months in the testing of Portland cement, lime, sand, mortars and concrete.

In the standard test for Portland cement it has been found that for a neat cement paste a spreading of the liner of about 0.25 in. under a drop of 3 in. corresponds very closely with a penetration of 10 mm of the Vicat needle. For the standard consistency of 1:3 mortar a drop of 2 in. produces an opening of about 0.25 in. With a medium stiff line putty a 3-in. drop produces an opening of about 0.40 in. and a lime sand mortar of rather stiff consistency gives about the same result.

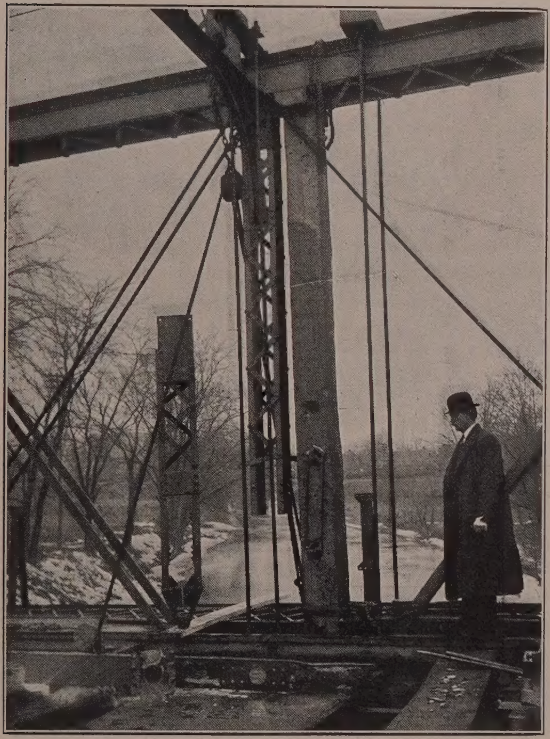
CONSERVATION OF THE WATER SUPPLY for the town of Stafford, Ariz., was the subject of a recently approved agreement between the town and the Department of Agriculture. Crook National Forest supplies the largest quantity of the water in question. According to the figures of the Forest Service there are nearly 1200 cities and towns in the West which derive their water supply from lands within the National Forests. Where these cities desire it the government joins hands with the citizens for the purpose of maintaining a permanent and pure-water supply. The co-operation agreement provides that the land may not be used without approval by the town, except for the protection and care of the forests. The government agrees to extend and improve the forests by seeding, planting, and forest management, so far as the funds for that purpose are available. The city, for its part, assists by paying the salaries of the additional guards necessary to carry out the agreement, and contracts to bear the greater part of the cost of any improvement work which it considers immediately desirable.

Novel Bridge Repair Job

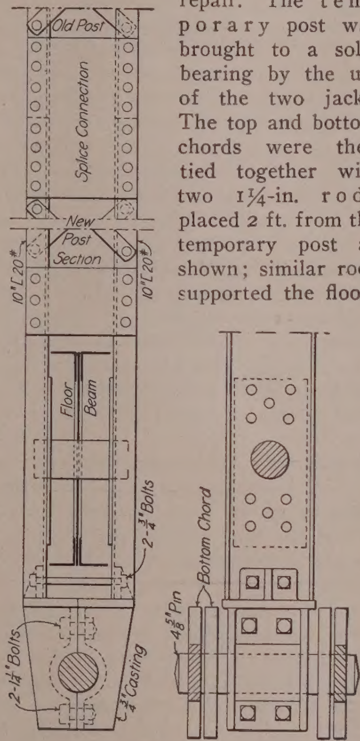
By Edward Stingel, County Engineer, New Philadelphia, Ohio

A novel method of repairing intermediate posts and hip verticals of a steel pin-connected Pratt truss highway bridge has been successfully completed at Uhrichsville, Ohio, by Mr. O. C. Hearing, of the Capital Construction Company, Columbus, Ohio. This bridge, which supports Third Street over Big Stillwater Creek, was erected in 1899 and has a span of 130 ft. from pin to pin, a clear roadway of 42 ft. and two sidewalks each 10 ft. wide.

Upon an inspection of the bridge it was learned that all the intermediate posts and hip verticals were badly deteriorated at and below the floor line, caused mainly by a faulty detail. The tie plates on the posts and hip verticals were riveted to the floorbeam cover plates, thereby forming pockets, which retained water for a number of days after each rain and allowed it to leak gradually and rust the metal. The deterioration brought on by this faulty detail was further increased by a lack of maintenance until the posts and hip verticals were so badly rusted that it was deemed necessary to either repair them immediately or to remove the bridge altogether.



Temporary Post and New Permanent Section



New Post Section

The first method of repair investigated was that of removing the posts and hip verticals and replacing them with new members, thereby necessitating the disconnection of the bridge. This would have required the erection of falsework and would have weakened, possibly, the connections by the removal of the old pins; to avoid any such damage to the bridge, and also to redcce the cost of the repairs to the minimum, it was decided to work up a plan of repair by which the defective ends of the intermediate posts and hip verticals could be removed and replaced by splicing with new material without necessitating the disconnection of the bridge.

To carry out this idea it was necessary to design a post and bottom chord connection which could be put into place without the removal of the old pin. The connection designed and used is a ¾-in. cast connection, cast in two pieces, which allows it to be put in place, and is held together by four 1¼-in. bolts. The intermediate posts rest on the cast connection and are bolted thereto as shown on the accompanying drawing. The posts were spliced with ⅜-in. flange-and-web plates designed to develop the full strength of the section.

The accompanying photograph shows an intermediate post with the cut-off made and the defective part removed; one of the old channels and pin plates are shown in the foreground, from which an idea of the extent of the deterioration may be had. The new post section, together with the cast-iron connection, is also shown.

The field methods used in making the repairs are, briefly, as follows: A 12 x 12-in. yellow-pine post, set on two 25-ton jacks resting on the bottom chord, was placed as shown on the accompanying photograph, temporarily taking the place of the post under repair. The temporary post was brought to a solid bearing by the use of the two jacks. The top and bottom chords were then tied together with two 1¼-in. rods placed 2 ft. from the temporary post as shown; similar rods supported the floorbeam from the top chord. By this method of tying, with the aid of the jacks, the distance between chords could be regulated, which was necessary at times to release the saw when it became pinched.

After the bracing and tying was completed the post under repair was sawed through with a hacksaw operated by two men, without any measurable deflection taking place, at a point 42 in. above the floor line; the part of the post below the cut-off was removed and replaced with new material. The bottom-chord pin and connections were thoroughly cleaned and all parts inaccessible when the post was in place were painted. The two-piece casting, upon which the success of this method of repair depends, was then placed over the bottom chord pin and bolted together, all bolts being upset.

The new section of post was set in place on the top of the casting, connection at the lower end being made by bolting to the casting and at the top by splicing to the old post section remaining in place. The method followed in making these repairs proved to be a speedy one; the average time on each post in the field, employing three men, was two days. The usual city traffic was maintained during the progress of the work.

Irrigation Pumping Plants

While various types of engines and motors are used for driving pumps on irrigation projects the electric motor, direct-connected to a centrifugal pump, is more generally used in Idaho than any other type. The installation of these plants naturally introduces problems with which the irrigation managers on a gravity project have no concern. The factors involved in securing high efficiency for the installation as a whole are many, and with the idea of getting a comprehensive view of the subject Mr. E. V. Berg, chief engineer of the High Line Pumping Project at Twin Falls, Idaho, presented and discussed the various factors before a recent meeting of the Idaho Society of Engineers. The following abstract gives the main points brought out.

Charging for Power

There are two methods of power charge in vogue—the meter rate with a fixed minimum and the flat rate. Both ways of charging have advantages, though the meter rate is apt to be more favorable to the consumer. The feature of the meter rate is that it gives the operator a chance to economize and take advantage of moist springs and of rains during the growing season. On the flat-rate basis a seasonal charge of a certain amount per horsepower is made, figured on a certain short-time maximum of power used during the season. In certain cases where the majority of the acreage is in cultivated crops, like fruit, potatoes, corn, beans, etc., it may be possible by early watering and much cultivation to keep the peak load down, but in case the tract is set to diversified crops, such as grain and alfalfa—which are not cultivated and which must have a large amount of water during the hot weather—the peak is bound to be high. However, the power bill is always the largest item of expense, and, therefore, all parts of the system should be designed so that operation may be conducted with the greatest efficiency.

In an analysis of the losses which are chargeable to the pumping system it is necessary to begin at the low tension or meter side of the transformers. The wiring and switch loss between transformer and motor in a properly designed plant is negligible and need not be considered. For motors of 100 hp 90 per cent efficiency is usual, while for sizes above 500 hp 94 or 95 per cent is not uncommon. The electric motor for pump drive is ideal. It is simple and reliable and has a high efficiency.

Pump Losses

The centrifugal pump has not yet attained the efficiency of the electric motor, but in simplicity and reliability it is a worthy partner. One of the sources of mechanical loss in a pump is poor stuffing-box design. A roughly made or short box will allow air to enter or water to escape, unless the gland is drawn up very tight and packing compressed to such a degree as to heat. The bearings should be ring-oiled and the babbitt properly grooved to distribute the oil. In case thrust bearings are required a proper pressure balance on the impeller or special provision in the bearing itself must be made. The mechanical losses are frictional and incident to all machines. The hydraulic losses are more complicated and are peculiar to the centrifugal pump and the water turbine. They are due to friction and shock, the latter being caused by changes in velocity at the various points of passage through the pump.

The suction intake should be of ample size, and whatever bends or elbows are necessary should be of long radius. If the impeller is constructed according to proper design, the blades are few in number and as short as possible for the given speed. The blades should be so curved as to give the greatest hydraulic radius at every successive point in passing through the impeller—i. e., the water cross-section as compared with the wetted perimeter should always be a maximum. The guide vanes and casing should be built so that the change from velocity head to pressure head at pump discharge shall be as gradual and uniform as possible, which will then convert the largest per cent of velocity head into pressure head.

The sum of all the losses in a good pump amounts to about 25 per cent of the power input on the shaft, representing an efficiency of 75 per cent. In special cases, or where unusual refinement was attained, 80 or even 85 per cent has been reached.

PLANT LAYOUT AND PIPES

In the general plant layout economy is promoted if the total power requirement is divided into several medium-sized units instead of using only one or two large units. This is done to supply the necessary water at the various seasons without running a large machine when only a small amount of water is needed. In case there are two lifts, but all the machinery is in one building, it would tend toward economy to have one unit designed for the high lift, but only about one-half the size of the remaining units. The piping could be so arranged that by manipulation of the valves discharge could be either in the high-lift pipe or in the low-lift pipe.

The next link in the chain is the pipe which conveys the water from the pumps to the canal or reservoir at the upper level. In fixing the size of pipe either the interest on investment is made to equal the cost of the losses or a certain arbitrary loss in per cent of total power is allowed and size calculated to conform to that condition. The first of the two methods would be applied something as follows: Compare two sizes of pipe in total cost of installation, then figure interest on the total cost and depreciation on the material cost only. Now, the larger pipe will, of course, show the greater cost, but will also show the greater efficiency. If the increased efficiency of the larger pipe indicates a greater power saving than the extra interest and depreciation cost, then the larger pipe is the one to adopt.

ALLOWING FOR PIPE LOSSES

According to the other system a certain per cent loss is allowed in the pipe and the size calculated therefrom. Mr. Berg has used the following method, which seems reasonable and satisfactory: Allow 3 per cent loss in pipe for the first 3000 ft. of length when pipe is carrying one-half its full-load capacity, and allow 1 per cent in addition for each additional 1000 ft. of length. The reason for using one-half the maximum is that this is roughly the average amount of water carried during an irrigation season. Assume, for example, that a wood pipe is to carry a maximum of 20 sec.-ft. to a height of 40 ft. Since power required is directly proportional to head, a loss of 3 per cent would be equivalent to adding to the total head 3 per cent, or in this case 1.2 ft. Now the 1.2 ft. is available to be used up by friction and velocity head, and it is found that for a 1000-ft. length a 26-in. pipe will carry the required 10 sec.-ft.; for a pipe 2000 ft. long this allowable loss must be distributed over twice the former length, and it is found in this case that a 30-in. pipe would be required. Likewise a pipe between 2000 and 3000 ft. long would have the same given losses distributed over three times the length and a 32-in. pipe would be required. When pipe exceeds 3000 ft. it is found that adding 1 per cent loss per 1000 ft. is sufficient to take care of the additional loss and the size of pipe remains the same as for the 3000-ft. length. According to this system pipe for low head figures out larger than pipe for higher heads, which is as it should be, since high pressure and smaller pipe come to about the same price as low pressure but larger pipe.

DITCHES

The next item in the irrigation scheme is the ditch system. Mr. Berg believes in parallel canals. This not only for the reason that it is more economical to pump to different elevations, rather than all the water to one high elevation, but because each of the parallel canals, except the upper one, will catch any waste that may come down from the land immediately above. It is true that two parallel ditches would cost more to construct and the seepage and evaporation losses might be a little greater than in the case of one large canal of the same capacity; but the extra cost and extra losses are compensated for in that fewer laterals need be constructed to bring the water within specified distance of the land to be watered. The canals should be built with the largest hydraulic radius practicable for the given grade, as this will insure the least seepage and evaporation losses. A concrete-lined, wood-pipe or oiled canal would add greatly to the efficiency of the system, as the losses from seepage would be reduced to a minimum, and in the case of concrete lining, or wood pipe, the ditch-maintenance cost would be almost eliminated. There may be cases where the concreting of a canal at the beginning, expensive though it be, might be an actual saving when the total cost of the project is considered, for approximately half the yardage would be saved over an earth canal, and the saving in water might be sufficient to warrant a great reduction in the size of the pumping plant, pipe lines and other works. An important feature of the ditch system is efficient and accurate measuring devices, so that the ditch rider may know to a certainty how much water each irrigator is getting.

CONTROL OF THE FARMS

Under a pumping system a certain measure of control should extend over the landowner's operations. Anything that may add to the economical use of the water after it leaves the main ditch should be impressed on the farmer. Each farm should be required to be properly laid out as to head and waste ditches, direction of furrows or corrugations, etc. It has been thoroughly demonstrated that runs should not be over 400 to 500 ft. long between head ditch and waste ditch for the most economical duty of water, and this practice should be advocated. There could be some regulation as to location of various crops on a farm—i. e., those requiring a large amount of water to be at the upper end of the farm, nearer the source of supply, and the cultivated crops, which require less water and can utilize whatever waste there is from the upper field, at the lower end.

On the tract with which Mr. Berg is connected (the High Line Pumping Project at Twin Falls) it is believed that a system of maintenance and operation charge will be tried whereby a certain fixed sum, probably about two-thirds of the total estimated cost of the season, will be charged against every acre of land whether in crop or not, the excess to be charged to those actually using water and in proportion to the amount used. In this way a careless irrigator would have to pay for his wastefulness, while a good irrigator would be rewarded by having a lower maintenance fee charged him.

Pumping for irrigation is a success, Mr. Berg stated. There is no longer any doubt about the machinery or the steadiness or quantity of water which can be supplied, but these things are attained at a greater cost than is the case under gravity flow. In order to make up or compensate for this disadvantage greater refinement and knowledge must be applied.

Small-Sized Drawings for Construction Work

Drawings of practically all development work now being done by the Western Canada Power Company are being made on 8 x 10-in. sheets, the only exception being topographical maps, which are four times as large. The small size has been adopted as standard because it has proved to be very much more accessible and convenient and affords a saving in time and cost. This system also makes it feasible to combine in the same letter file all designs, calculations and bills of material for any given part of the work.

The general method followed is to prepare a small-scale drawing of as large a section of the work as convenient, say the entire penstock line, putting this on a single sheet. Each section is then drawn in detail on a separate sheet, the scale in the latter case being large enough to make the drawing suitable for construction purposes. The scale usual for general plan drawings is about 20 ft. to the inch, while the details are drawn on scales as large as 1 in. to the foot.

Two additional time-saving features have been introduced in this system—all lettering is done by typewriter and steel and concrete areas are colored so as to save the time usually required for filling-in conventions. By applying the color on the reverse side of the tracing the necessity for care to avoid washing the ink lines is eliminated. To bring the lettering out more plainly on the blueprints the tracings are put in the typewriter with a piece of carbon paper facing the reverse side of the sheet. This gives a doubly heavy color in letters and figures. Not all grades of tracing cloth or paper are suitable for this work, due to the blurring of the typewriter ink and carbon. The preferable grade is a firm, smooth paper lacking the glossy finish and having a high degree of transparency. That used for the work mentioned is K. & E. "Colonna."

The system of small drawings was inaugurated by Mr. G. A. Gaherty under the direction of Mr. R. F. Hayward, chief engineer of the Western Canada Power Company, and was adopted for all work in hand after it was found impracticable to make photographic reproductions of large sheets. The results of the small drawing system have been so good, Mr. Hayward states, that since it was put in use no larger sheets have been used, although the company now has under way a power-house extension to accommodate two 15,000-kw units, and involving a floor space of 75 x 100 ft.

The metric system is used throughout on the small sheets and is said to be specially convenient for hydraulic data, such as the rating of reservoir capacities at various levels in kilowatt hours.

Irrigation and Power Canal in Louisiana

Connection of the Red River with southwestern Louisiana through an excavated canal 200 ft. wide at the bottom and 20 ft. deep, to be used for irrigation, navigation and hydroelectric power, is being investigated by Mr. Welman Bradford, of Alexandria, La. Three possible routes are being studied and it is expected that before long the final plans will be decided upon.

Making the canal navigable will fill a long-standing need for cheap internal transportation to the territory lying between the Red River on the north and the intercostal canal system in southern Louisiana. The whole system will then connect through the Red River with the Mississippi River, its valley and tributaries.

The irrigation system will solve the great problem which the rice industry has had to contend with during the last fifteen years, i.e., the shortage of fresh water with which to develop a sufficient supply of rice. The amount of water which will pass down the canal during the irrigation season, which coincides with the high water in Red River during the spring and early summer months, is estimated at more than 600,000 acres.

There will be developed through three hydroelectric stations from 30,000 to 40,000 hp, should there be a market for it. Along the banks of the principal canal there will be trolley lines connecting with other systems now under construction and consideration, with a system of modern steel canal barges propelled through the canal by electric power.

When this system is completed and the undeveloped lands are cultivated, it is estimated that Louisiana, with the various systems of irrigation now existing in the southwest, will be able to supply the full demands for rice during the next three generations, besides filling the need for a cheap transportation of sugar cane, which could be produced all over this section of Louisiana.

The projected canal routes, three in number, are as follows:

One contemplates a connection with Red River at Grand Ecore in Natchitoches Parish, passing through the Cane River and renewing navigation on that stream to the point where it empties into Red River near Colfax, this point to be dammed up. Continuing southwesterly through the swamp lands of Rapids Parish, it will cross the Watkins railroad at a point from 8 to 10 miles south of Alexandria, then continue south and southwest through St. Landry Parish near the Rock Island road, and from there branch off southward into two or more sections, one to connect with Bayou Teche at a point to be selected and the other to connect with the intercoastal canal in Calcasieu.

A second route is proposed to commence at Red River where Cane River empties into it near Colfax, and then to pursue the same course as outlined for route one.

A third contemplated route would leave Red River at a point near Alexandria in the vicinity of the Iron Mountain Railroad bridge, crossing Bayou Rapides near the city and from thence traversing the same route mentioned above.

The originator of the plan, Mr. Welman Bradford, succeeded about eighteen years ago in introducing the "shallow contour" levee system, which it is stated saves more than one-half of the amount of water used in the "rectangle system" of irrigation. This had the effect of extending irrigation to lands heretofore considered worthless. A late development is the introduction of steam pumps, pumping up water from the stream and distributing same through surface canals into fields and through these contour fields from the higher gradually down to the lower ones, each contour holding its exact amount of water. This, it is stated, further reduced the cost of production about one-half.

In 1906 Mr. Bradford was invited to introduce his system in Brazil and before he left that country in 1911 he had succeeded in improving the conditions of rice culture considerably. In 1906 Brazil was importing more than 22,000 tons of rice to supply its home demand, but in 1911, five years later, it not only raised enough for its own supply, but it even exported to the Argentine Republic about 8000 tons, indicating an increase in production of at least 30,000 tons during the period of five years.

Book Reviews

Dr. Charles A. Lauffer's booklet, "Resuscitation," is, in substance, a paper on resuscitation from electric shock, drowning, asphyxiation, etc., as read before the Philadelphia Electric Company section of the National Electric Light Association. It gives in a few words, supplemented by several illustrations, the functions of the diaphragm and the way to bring it back to its normal action by the prone pressure or Schaefer method after natural respiration has failed. Dr. Lauffer truly points out how men well posted in dynamos, motors and turbines should also give attention to the human engine. (New York, John Wiley & Sons.)

The first volume of "Transactions" of the Efficiency Society is a 450-page book giving in full the addresses delivered at all of the meetings during 1912. Taken together, the addresses form a very valuable symposium on the application of efficiency methods not only to them anufacturing division of an industry but also to sales, advertising, purchasing and methods of employment. (New York, The Efficiency Society).

A circular chart designed to eliminate long multiplications and divisions and to reduce the work of squaring, cubing, finding square and cube roots, determining areas and circumferences of circles, has been published by Mr. George N. Purver, 146 East Eighth Street, Brooklyn, N. Y. It is intended for the use of estimators, statisticians, engineers and others in need of devices for obtaining mathematical results rapidly. The price of the chart is 50 cents.

"Die Zeitschrift des Vereines Deutscher Ingenieure" has published in pamphlet form drawings used to illustrate the text of articles printed during 1912. The illustrations are arranged on sheets 12½ x 19 in., folded twice, and bound in strong folders containing eight sheets each. The data are especially valuable for use at the drafting board and for illustrating lectures in technical schools. The material is arranged in groups for the different branches of engineering. The first two volumes which have appeared are devoted to "Vehicles" and "Hoisting Engines and Cranes." Later volumes will deal with "Engines," "Civil Engineering" and "Materials and Machinery for Their Production." The first folder contains illustrations of locomotives, different kinds of railway carriages, benzo-electric locomotives, motor fire engines, etc., and the second contains plans for pneumatic mail transportation, blowers, pumps for waterworks, structural steel cranes, etc. The price for each folder of eight sheets is 30 cents for teachers and students, 45 cents for members of the society and 60 cents for others; postage to foreign countries is 2½ cents. (Berlin, Verein Deutscher Ingenieure.)

Der Bau der Wolkenkratzer. By Otto Rappold. Cloth, 6½ x 9½; 263 pages; 307 text figures and one insert. Munich, R. Oldenbourg, 12 M. net.

The "Construction of the Skyscraper" is a book based upon information collected in the United States; much of the material is taken from American technical literature, especially from the Engineering Record. It is written with the intention of familiarizing German engineers with American building methods, although the construction of skyscrapers is forbidden by the German laws. The book is up to date—even the Woolworth and Municipal buildings in New York City are described and shown in course of construction. The descriptions of details are good and the material is arranged in a logical manner.

The Design of Simple Steel Bridges. By P. O. G. Usborne. Cloth, 6 x 9; 369 pages; 307 figures. New York, D. Van Nostrand Company, $4 net.

This book is a revision and rearrangement of the author's former work entitled "Manual of Bridge Design," used as a text book by the Royal Engineers at the School of Military Engineers, Chatham, England. The work is confined to simple bridges of the beam, plate-girder and simple-truss types, including loadings, floor arrangements and girder details and design, applied to both railway and highway bridges. The author's professed aim is ever to keep before the student the practical object for which he is striving. To this end he has avoided all but the simplest mathematics and has constantly illustrated principles by practical examples taken from actual practice.

The author has a proclivity for graphical methods which, to our American way of thinking, seem a little tedious and cumbersome. It is the only method given for wheel loads. Thus, for bending, an influence diagram (he does not call it by this name) is to be drawn for each wheel, supposing it to roll across the span by itself, and then all of the diagrams are to be combined into one, having regard to the spacing of the loads. The use of the simple criteria for locating wheel loads for maximum moments and shears and of the moment table for getting numerical results, so universally used in this country, is not mentioned at all.

The book is elementary, mainly descriptive, and, written for English practice, is of little value in this country. It is interesting in illustrating the British method of handling a subject which has received such complete and careful analytical treatment on this side. After all, it is a little ungracious for an American reviewer to pass in judgment upon a work so obviously not intended for our own readers. Doubtless the book will find a useful place in its own country.

Some years ago the present reviewer visited the exposition in Glasgow and came across the exhibit of an English technical book house. He was surprised to find there almost a complete set of the best recent American works on structural subjects and to be informed that there is a high appreciation and a steady demand for them in Great Britain.

Die Wasserkräfte, ihr ausbau und ihre wirtschaftliche Ausnützung. By Adolf Ludin, Doktor-Ingenieur and Grossherzoglicher Bauinspektor. Cloth, 8 x 11; two volumes, 1404 pages; 1087 illustrations in the text and 11 inserts. Berlin, Julius Springer, 60 M. net.

This book has a peculiar history. On July 1, 1908, the Royal Academy of Building Construction in Berlin announced a prize contest for a book describing and comparing modern hydroelectric developments. The manuscripts had to be delivered before Jan. 15, 1909, allowing only six and a half months for preparing the work. All graduate German engineers were permitted to participate and a prize of $715 was to be awarded. The Academy also was to provide the winner with additional funds for travel and inspection, so that he may have an opportunity to revise and amplify his book.

The jury awarded the prize to Herr Adolf Ludin, doctor-engineer, of Baden. After the Academy had approved a schedule of visits of inspection Herr Ludin traveled through Germany, Austria, Switzerland, northern Italy, and France, collecting additional information. He completed his revised work in 1911.

The book comprises two volumes and is divided into three parts. Part 1 deals with the present forms for hydraulic power-plant designs and the physical laws governing their development.

The most valuable portions of the book are the second and third parts. Part 2, comprising 569 pages, contains not less than twenty-four complete descriptions of European power plants. These descriptions, while mostly reprints from technical journals, are very valuable. Part 3, pages 767-1375, deals with details for power plant designs. The subjects treated are gravity and movable dams of various types, means for conveying water and power station details.

The book is well written and should prove of interest to engineers and others occupied with the development of hydroelectric power.

Letters to the Editor

Micro-Organisms in Water

Dear Sir: In your issue of June 14, page 676, the writer notes the trouble encountered at the Evansville filter plant in clogging of filters by micro-organisms. Toward the latter part of April a similar condition affected the filter plant at Moline, Ill., the hours of service being reduced to about eight. During periods of clear river water in the spring and fall this same condition has occurred heretofore, the organisms increasing more rapidly at this time. The supply is obtained from the Mississippi River, treated with alum as a coagulant and calcium hypochlorite for sterilization. The time of coagulation is two and a half hours.

Microscopical tests of the water showed the presence of asterionella, synedra, cœlastrum, melosira, uroglena, fragilaria and a few other forms with asterionella, synedra and cœlastrum predominating. A strong fishy odor was noted at the same time.

Copper sulphate was added at the rate of 1 part per million, fed in with the alum intermittently. A continuous feed for twenty-four hours was maintained and then the treatment discontinued for twenty-four hours. Three such treatments resulted in increasing the period of service of the filters, but not in a complete removal of odors.

L. A. Fritze,
Moline, Ill. City Chemist.

Precautions Suggested by the Lexington Avenue Subway Tunnel Accident

Dear Sir: The tunnel accident at Fifty-sixth Street and Lexington Avenue, New York, which occurred on June 14 and cost the lives of ten workmen and seriously injured three others, has suddenly brought the attention of the public to the dangers to life and property that exist in tunneling through rock for the new subways. Some have reported that this accident was due to "culpable negligence," and others have claimed that it was more due to unforeseen conditions and not to any element of negligence on the part of either the Public Service Commission or the contractors.

A similar accident occurred on Park Avenue in front of the C. T. Barney residence during the construction of the present subway, resulting in almost the complete destruction of the house. This accident was due to the sudden encountering of a large seam in the rock which permitted the flow of material from under the foundations of this building into the tunnel excavation.

During the construction of the crosstown Pennsylvania tunnel at Thirty-third Street and Fifth Avenue the Cambridge Building would have collapsed had not the engineers employed by the owners found that the walls of the building were settling to a dangerous extent. In this case the material around the timber piles which supported the building seeped into the excavation through a seam suddenly encountered in the rock. The cost of rebuilding these foundations amounted to about $20,000. Similar damage has been caused in other parts of the city, but of less importance.

During the past ten years the writer has been employed by property owners along the route of subway excavation to inspect the construction work in front of their property and to look after their interests. He has had occasion to study the methods used on the old subway, the Centre Street loop, the subways now in course of construction, the Pennsylvania and McAdoo tunnels, and the city aqueduct, and in general would say that in case of rock tunneling where the inflow of water and occurrence of seams was to be expected the contractors have employed methods that would be considered general practice for work of this character. It has generally been found that in tunnel accidents of this kind the cause has not been faulty material or insufficient design, but unforeseen conditions. The driving of a tunnel under such conditions is comparable to the progress of any army in battle, where the men are continually exposed to unforeseen conditions.

In tunneling through solid rock it is customary to make preliminary borings to predetermine the character of rock that may be encountered. Where borings show solid rock it is customary to blast out the material about 1 ft. beyond the neat line and leave the roof without any timber supports. Where it is expected to find unsound conditions, such as water-bearing seams or pockets of soft rock, it has been customary to safeguard the work and the men by supporting the roof with temporary timbers.

It has often occurred to the writer that some methods similar to the driving of vertical tunnels or shafts, such as have been used in European countries where excavations are carried through seamy and water-bearing rock, should be applied in horizontal-tunnel excavations where the conditions are comparable. In sinking some of these deep-mine shafts men and workings are protected through every foot of depth by lining the shaft with an armor consisting of sections of steel or cast iron bolted together. This lining of steel is supported from the surface and as the excavation progresses new sections are added from below. This is what is called the underchanging method of lining a shaft. Under extreme conditions the very costly freezing process is used, in wet soft ground, and the writer has visited a shaft where an 18-ft. circle was frozen 1000 ft. deep.

To line a rock tunnel with steel tubing might be considered in ordinary cases uneconomical, but some method where the use of an inner lining composed of small sections of concrete blocks dovetailed or bonded in some way with adjoining sections, comparable to the steel tubing or lining used in European shafts or in the East and Hudson River tunnels, might well be considered in rock excavations such are are now carried on in this city, where an inner lining of concrete must be constructed under all conditions. Such an interior sectional concrete block has been used in Europe for mine shafts. As far as the writer knows a lining of sectional blocks of concrete forming an arch has never been used in this country, but what is known as the Haas system has been used abroad. An American system, designed by Mr. John F. O'Rourke, has recently been devised in which an arch is formed of concrete blocks bonded together in a suitable manner. These can be used in wet ground and in rock tunneling and will avoid the necessity of using timber for supporting the loose material overhead. Such a scheme should prove practical and economical and would be one of the safest methods to be used in tunneling in such rock as is found in New York City.

Vibration caused by street traffic, the operation of machinery in adjoining factory buildings and blasting within or near the tunnel are other conditions which might be contributory causes to accidents, such as have been referred to above. The public is generally too quick to pass judgment as to the cause of such accidents, but where civilization is progressing such accidents have followed its course, and it is frequently through nature's warning that engineers have learned lessons and have adopted methods which otherwise might have been conceived only at some future time.

The writer has known of instances where the blasting of rock at considerable depths below foundations of buildings several hundred feet away has caused material settlement in those buildings. The operation of machinery in a certain building has been known to have produced dangerous vibrations in other structures 200 ft. away. In excavating near adjoining buildings containing heavy vibrating machinery great care should be taken in the protection of such excavations from the possible effect of vibrations. Wherever extensive rock tunneling is carried on it should be the duty of the engineer to study not only the conditions that may be encountered underground, but also such conditions as have been referred to above.

New York City. Maurice Deutsch.

Suez Canal Traffic for 1912 amounted to a net tonnage of 20,275,120 as against 18,324,790 tons in 1911. In 1912 the vessels passing through the canal numbered 5,373. In spite of the reduction on Jan. 1 in the transit dues from 7.25 to 6.75 francs per ton the gross receipts amounted to the record figure of 136,423,831 francs as compared with 134,762,199 francs in 1911.